ASTM BULLETIN

DECEMBER 1953

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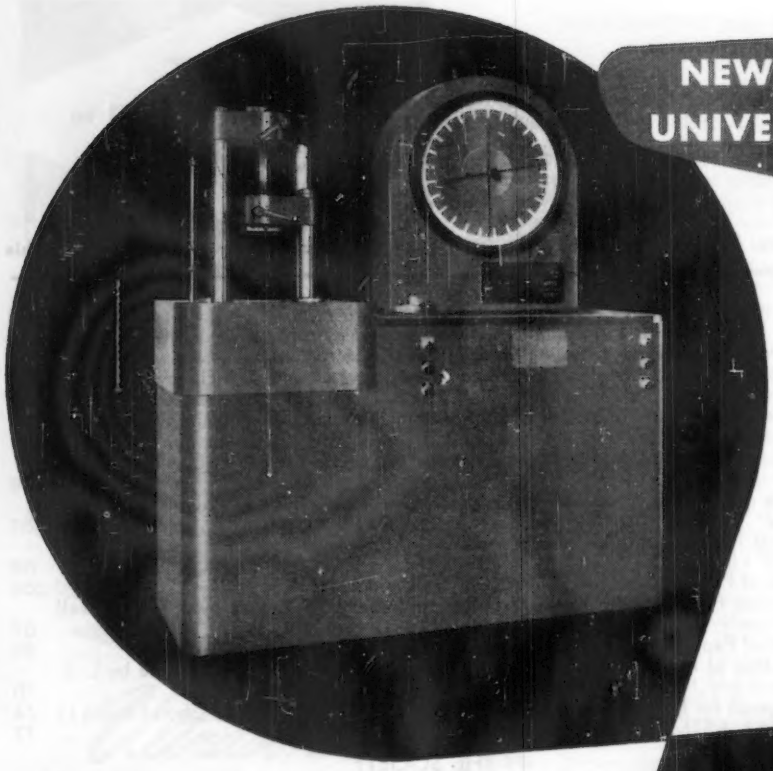
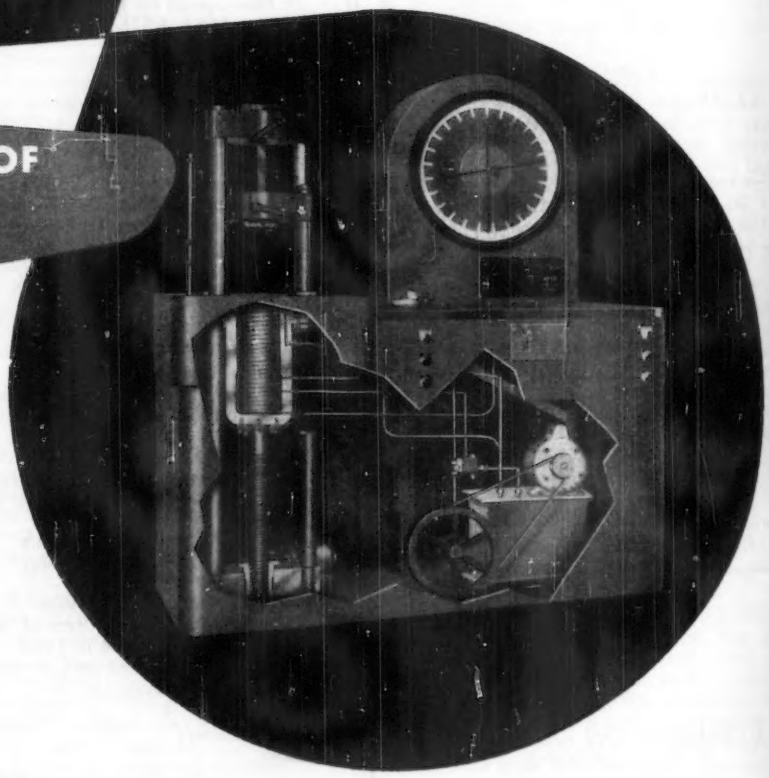
NEW, COMPACT SINGLE UNIT UNIVERSAL TESTING MACHINE



- Built as a single unit so that floor load is distributed over large area.
- Overall dimensions less than two unit machine (only 67½" wide by 27" deep).
- More compact machine (indicator only 77½" high and loading cage 73¼" high).

WITH ADVANTAGES OF TWO-UNIT DESIGN



- Gage panel is supported separately by a framework which extends to the floor, preventing the shock of breaking specimens from being transmitted to the load indicator.
- Therefore, recoil is not transmitted to the indicator and cannot jar the maximum hands out of position.
- Friction of the maximum hands can be adjusted to the maximum necessary for accurate indication.

This low-cost Baldwin 60-H universal testing machine of 60,000 lb. capacity has many other advantageous features. For complete technical information please write for Bulletin 4204 to Dept. 2103, Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa.

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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

Number 194 DECEMBER, 1953

Nation's Capital Scene of 1954 ASTM Committee Week, February 1–5

Two Symposiums—Color—Design of Experiments—Feature Technical Groups' Meetings at Shoreham Hotel

THE yearly gathering of numerous ASTM technical committees in a week of meetings, February 1–5, at Washington's Shoreham Hotel, will be enhanced by a Symposium on Color and a Symposium on Design of Experiments.

Cooperating with the Shoreham in providing meeting rooms and accommodations will be the Sheraton Park Hotel (formerly the Wardman Park). Both hotels are located in Washington's beautiful northwest embassy-residential section.

Taking advantage of the opportunity presented by Committee Week to concentrate their meetings in a given time and place with the resultant saving in travel time and expense, scores of meetings of technical committees and their subdivisions have been scheduled for the week of February 1.

Reservations

Hotel reservation forms will go into the mails shortly to all members and committee members. Those who expect to participate in Committee Week activities are urged to return these forms as promptly as possible in order to obtain the accommodations they desire.

Symposium on Color

Sponsored by Committee E-12 on Appearance, this Symposium will be held in two sessions, morning and afternoon, of Wednesday, February 3. The speakers will review color measurement and control techniques in those industries in which the color of transparent and translucent materials is important. The papers will reveal the unevenness in the development of methods among industries and the inadequacies, limitations, and unsolved problems that sometimes prevail. They will emphasize the dollar value of these problems so that where research programs are required they can be adequately launched and their costs justified.

Industrial fields which will be represented in this presentation are: glass, naval stores, plastics, brewing, paints, foods, color styling, essential oils, dairy products. Authors of papers in these respective fields are as follows:

C. E. Leberknight, Kopp Glass Co.
R. H. Osborn, Hercules Powder Co.
G. W. Ingle, Monsanto Plastics
Irwin Stone, Wallerstein Laboratories
R. H. Kienle, Calco Chemical Div.
W. Gould, Ohio State University
W. Granville, Container Corp.
H. Wachs, Dodge & Olcott
H. Campbell, Delare Assn.

Deane B. Judd, Physicist, National Bureau of Standards, will summarize these papers at the close of the session and preside over a brief question-and-answer period.

Symposium on Design of Experiments

Committee E-11 on Quality Control of Materials is preparing to hold a Symposium on Design of Experiments on Tuesday evening, February 2.

This rapidly developing field of statistical application to engineering will be well represented by three outstanding experts who will present papers on the subject as follows:

The Purpose of Experimental Design, by W. G. Cochran, Professor of Biostatistics, Johns Hopkins University

The Shoreham

An Engineering Application of Experimental Design, by Besse B. Day, Statistician, Naval Experimental Station
Design of Experiments and Physical Sciences, by W. J. Youden, Consultant, National Bureau of Standards

Mr. Youden is serving as chairman of the symposium committee and William B. Pabst, U. S. Navy Department Bureau of Ordnance, will act as chairman of the session.

Committee Week

Committee members will be advised by their officers of the details of time and location of their meetings in Washington, D. C. As this issue of the BULLETIN goes to press, the following 40 committees have indicated their intention to meet during Committee Week:

A-3 on Cast Iron
A-5 on Corrosion of Iron and Steel
A-7 on Malleable Iron Castings
A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys

B-1 on Wires for Electrical Conductors
B-2 on Non-Ferrous Metals and Alloys
B-3 on Corrosion of Non-Ferrous Metals and Alloys
B-5 on Copper and Copper Alloys, Cast and Wrought
B-6 on Die Casting Metals and Alloys
B-7 on Light Metals and Alloys Cast and Wrought

C-1 on Cement
C-2 on Magnesium Oxychloride and Magnesium Oxysulfate Cements
C-3 on Chemical-Resistant Mortars
C-7 on Lime
C-8 on Refractories
C-9 on Concrete and Concrete Aggregates
C-11 on Gypsum
C-12 on Mortars for Unit Masonry
C-15 on Manufactured Masonry Units
C-16 on Thermal Insulating Materials
C-18 on Natural Building Stones
C-19 on Structural Sandwich Constructions
C-22 on Porcelain Enamel

D-1 on Paint, Varnish, Lacquer, and Related Products
D-3 on Gaseous Fuels
D-4 on Road and Paving Materials
D-8 on Bituminous Waterproofing and Roofing Materials
D-11 on Rubber and Rubber-Like materials
D-16 on Industrial Aromatic Hydrocarbons and Related Materials
D-19 on Industrial Water
D-21 on Wax Polishes and Related Material

E-1 on Methods of Testing
E-4 on Metallography
E-5 on Fire Tests of Materials and Construction
E-7 on Non-Destructive Testing
E-9 on Fatigue
E-10 on Radioactive Isotopes
E-12 on Appearance

Joint Committee on Paint, Varnish and Lacquer

NEW ASTM PUBLICATIONS

Gillett Lecture: Effects of Minute Additions in Metal and Alloys

JEROME STRAUSS, "great metallurgist, practical engineer, and industrial trail blazer" presented the H. W. Gillett Lecture this year. In his own right he has added immeasurably to our knowledge of alloy steels, especially on industrial applications. Now Vice-President and Director of the Vanadium Corporation of America, Mr. Strauss can also look back with justified satisfaction on a record of service to his country. He was a metallurgist for the U. S. Naval Gun Factory. During World War I he served with Army Ordnance and during World War II he was on numerous gun-steel committees including the Metals Conservation and Substitution Group of the Advisory Committee on Metals and Minerals of the War Metallurgy Committee.

Mr. Strauss has been active in ASTM since 1916. For many years as Chairman, he has guided Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys. Thus he is well qualified to speak on Micrometallurgy and the effects of minute additions on the properties of steels.

Lecture Comprehensive in Scope

Transitor development, based on behavior of certain semiconductors, and boron-steel alloys development have produced atomic-bomblike effects on their respective industries. Common to both of these developments is the implied theme that in the presence of minute quantities of elements added (or substracted) in an "old" system of material, extraordinary effects on the properties of the system sometimes result. The enhanced properties can have tremendous industrial significance.

This theme has been used by Jerome Strauss in his Gillett Lecture. The lecture constitutes probably the first piece of technical literature which is devoted *entirely*—over a broad range of metallurgical experimentations and practice—to the effects of small additions.

In "Micrometallurgy—the Metallurgy of Minute Addition," Mr. Strauss reviews and comments upon the growing number of major effects upon metals and alloys resulting from or associated with minute change in composition, many of them dealing with quantities "ever so much smaller than the content of carbon in the steels" themselves. He hopes "that by bringing a large number of them to your attention simultaneously and treating at least some in a critical fashion," he may be able to stimulate other workers to extend further our knowledge of these phenomena. His scope is "the full range of metallurgy, for such is the scope of the Society's interests."

More specifically he discusses copper and its alloys, aluminum and its alloys, magnesium-rich alloys, silicon and germanium, platinum, tin, titanium or zirconium and the ferrous metals. Mr. Strauss has reviewed at some length the evidence on boron-treated steels. Sixty-three references are appended.

Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $1; to members, 75¢.

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Papers on Soap—A Reprint

AVAILABLE in reprint form is a group of 6 papers on Soap and Other Detergents. They have been collected from two ASTM BULLETINS, and brought together into a handy booklet. This reprint covers the following:

Analysis of Hard Water Soap—L. F. Hoyt and J. E. Walter
Detergents in Drycleaning—G. P. Fulton, J. C. Alexander, and M. Schwartz
The Effects of Detergents on Sewage Treatment Processes—R. Manganelli
A Dynamic Test for Detergency of Hard Surfaces—Manuel N. Fineman
Asphalt Tile Cleaner Specifications—A. C. Zettlemoyer
The Temperature Rise Test to Determine the Relative Amounts of Phases I and II in Sodium Triphosphate—J. D. McGilvery

This booklet should be a valuable addition to information previously published in *STP 115, Papers on Evaluation of Soaps and Detergents*, and *STP 139 Symposium on Statistical Methods for the Detergent Laboratories*.

The reprint contains 32 pages of text, graphs, tables, and illustrations and is priced at 75 cents (to members and nonmembers).

Symposium on Light Microscopy—an Important New Publication

JUST published is a tailor-made offer of valuable knowledge to those in the diverse fields of materials covered by ASTM—the *New* Symposium on Light Microscopy.

After seeing and hearing the eminents of light microscopy present the original papers last year, we thought that Symposium Co-Chairman, F. G. Foster and R. P. Lovel, had truly "done a job," and now in going over the page proof, we are convinced. It is because this symposium goes beyond the mere presentation of specialized information on light microscopy. It reveals the *true* scope and possibilities of light microscopy in industry today.

Probably too many engineers and scientists not closely concerned with microscopy have entertained a somewhat nebulous concept of the usefulness of this field. Perhaps to us, microscope meant bacteriology, medicine and clinical chemistry, or Pasteur and Koch, rather than steels, concrete, plastics, and textiles. We have not realized that new developments in schemes for light paths, illumination, and techniques, have resulted in microscopes which are versatile, powerful fact-finders.

There is a classic example of the "power" of the microscope. Two steels, identical in content of chemical elements have widely differing mechanical properties resulting from different heat treatments. Think of the importance of being able to say "through the microscope I *see* the structure of steel *A* to be different than steel *B*. When the parent steel is given heat treatment *x* it will look like steel *A*, be steel *A* and have the properties of steel *A*."

Actually, the symposium presents many examples of this new role of the light microscope from several typical fields of usefulness, and they are not oversimplified as in our steel example. We wish only to emphasize the newer possibilities of the instrument. The various authors have crammed their papers with fine photomicrographs, diagrams, and techniques. These papers are well referenced and there is included written discussion of the various papers. Almost 130 pages. Price, $2.50; to members $1.85.

• • •

ASTM to Distribute Infrared Index Cards

THE distribution of infrared index cards, based on the IBM punched-card system developed by L. E. Kuentzel of Wyandotte Chemicals Corp., is to be under ASTM's auspices after January 1, 1954. The ASTM Committee E-13 on Absorption Spectroscopy has assumed the responsibility for the continued maintenance and development of the index. Wyandotte Chemicals Corp. is continuing to cooperate in the work on the index and will print the cards for distribution by ASTM.

Committee E-13 has studied various existing codes for indexing infrared spectra and as a result certain changes have been made in the original Wyandotte system. The new index cards now being prepared, therefore, should not be intermixed with the old cards, which should be completely replaced by the new set. It is anticipated that no further substantial changes will be made in the coding system for the next several years, so that supplementary cards issued during that period can be intermixed with the set about to be issued. It is hoped that (*a*) greater stability and permanency of the revised system, (*b*) improvements in coding and sorting chemical structure, and (*c*) a greater guarantee of accuracy and wide coverage will be provided by the new arrangements and will enhance the very considerable utility of the current index so as to offset the cost of replacing the sets now in use.

The complete sets of index cards will cover spectra from the following sources:

American Petroleum Institute Project No. 44
National Research Council Committee on Spectral Absorption Data, Samuel P. Sadtler and Son
Current literature, as abstracted by groups under the sponsorship of Committee E-13

Index cards covering newly available spectra will be published at frequent intervals and will keep the system current and therefore of maximum utility.

Complete sets of the index cards to be available by January 1, 1954, will contain from 8000 to 10,000 cards and will be shipped prepaid at $10 per 1000 cards, with a copy of a revised booklet of codes and instructions being furnished with each set. Subsequent supplementary cards will be $1.25 per 100 cards.

1953 Supplements to 1952 Book of ASTM Standards

WITH the ASTM Book of Standards a triennial publication, it is kept up to date between publication years by the issuance of a set of supplements. The 1953 Supplements have now made their appearance; they cover the 7 Parts of the 1952 ASTM Book of Standards—they are essential to a complete file of ASTM Standards.

Listed below are the fields covered by the Supplements together with the number of new or revised standards which appear in each and these bring up to date the 1952 ASTM Book of Standards.

Part 1. Ferrous Metals—61 Standards
Part 2. Non-Ferrous Metals—49 Standards
Part 3. Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing, Soils—51 Standards
Part 4. Paint, Naval Stores, Wood, Sandwich Constructions, Building Constructions, Fire Tests, Wax Polishes—30 Standards
Part 5. Fuels, Petroleum, Aromatic Hydrocarbons, Engine Antifreezes—46 Standards
Part 6. Rubber, Plastics, Electrical Insulation—28 Standards
Part 7. Textiles, Soap, Water, Paper, Adhesives, Shipping Containers—46 Standards

Price of each of the 1953 Supplements is $3.50; to members, $2.75.

New Tentative Spectrochemical Methods

SEPARATE reprints are now available on two new ASTM Methods for emission spectrochemical analysis: the Tentative Methods for Spectrochemical Analysis of Aluminum and Aluminum-Base Alloys by the Point-to-Plane Spark Technique (E 101 – 53 T) and for Zinc Base Alloys and High-Grade Zinc by the Solution-D-C Arc Technique (E 27 – 53 T).

These methods, available at 25 cents each, are reprinted from the new 320-page book of "Methods for Emission Spectrochemical Analysis," which also includes two other tentative methods, three suggested practices, a suggested nomenclature, and 53 suggested methods, and is priced at $3.40 to members of the Society, and $4.50 to nonmembers.

Papers Committee Meets at Headquarters

Photographed at the committee's November 18 meeting, are left to right: L. S. Reid, R. C. Adams, L. C. Burroughs, L. W. Wood, G. A. Wilson, ASTM Staff, R. E. Hess, Chairman, M. Van Loo, T. J. Dolan, L. E. Gregg, F. L. La Que, G. R. Gohn, L. L. Wyman.

Symposium on Non-Destructive Testing—a Comprehensive Survey

ADVANCED non-destructive testing methods being used worldwide are now available in a new symposium. Specific problems have been included—ASTM'ers are being given a first-hand preview of the techniques used in Canada, Denmark, France, Holland, Italy, Switzerland, and United States.

Developed by Committee E-7, the symposium contains group of 8 papers and some discussions which have been listed below.

Introduction—S. A. Wenk
Comparison Radiographs of Welds—Alexander Gobus
Fluoroscopy and Radiography with Iridium 192—C. Garrett
Critical Study of the Techniques for the Testing of Materials by Ultrasonic Methods—Paul G. Bastien
Weld Radiography—Oscar Masi
Comparison of Non-Destructive Tests on a Damaged Sternpost—A. de Sterke and H. den Hartog
Progress in the Field of Non-Destructive Testing Through the Use of Ultrasonics—W. C. Hitts
The Practical Application of Ultrasonic Non-Destructive Testing—W. A. Felix
The Non-Destructive Electronic Sorting of Metals for Physical Properties—Fritz Förster

The Symposium discusses principally the testing of metal sheets, rods, castings forgings, machine assemblies, and the like; plastics are mentioned. Excellent data and ideas are presented for those interested in the non-destructive testing of other materials. In all of the papers there are numerous illustrations, photographs of graphs and tables.

Workers in the field should find the many references included to be of particular value.

"The Symposium on Non-Destructive Testing," *STP 145* (104 pages) is $2; $1.50 to ASTM members.

Offers of Papers for 1954

THE Administrative Committee on Papers and Publications will meet in early February to consider the papers to be published by the Society in 1954 and to develop the program for the Annual Meeting to be held in Chicago, Ill., June 14 to 18.

All those who wish to offer papers for presentation at the meeting and publication by the Society should send these offers to Headquarters *not later than January 15, 1954*. All offers should be accompanied by a summary which will make clear the intended scope of the paper and will indicate features of the work that will, in the author's opinion, justify its publication and inclusion in the Annual Meeting program.

Suitable blanks for use in transmitting this information will be sent promptly upon request to Headquarters.

Next Month—
A Summary of
ASTM Activities
in 1953

Petroleum Products Compilation

IN THEIR latest approved form, the 1953 edition of "Standards on Petroleum Products" includes over 100 test methods, numerous specifications, lists of definitions of terms on petroleum and on the rheological properties of matter.

This special compilation is one of ASTM's most widely distributed publications. It reflects the intense interest there is in evaluating the properties and quality of a wide range of petroleum products. It is sponsored by Committee D-2 and has been published each year since 1927. In the 1953 edition several appendices cover the following proposed tests:

Functional Life of Ball Bearing Greases; Chlorine in Lubricating Oils; Sodium in Residual Fuel Oil by Flame Photometer; Weathering Test for Liquefied Petroleum Gases; Water in Petroleum and Bituminous Products; Analysis of Graphite; Flash Point of Volatile Solvents by the Tag Open-Cup Apparatus; and Proposed Recommended Practices for Applying Precision Data Given in ASTM Methods of test for Petroleum Products and Lubricants.

Petroleum chemists and other technologists in the industry, purchasing agents, sales engineers, and many engineers and experts in automotive, aircraft, tractor, and railway fields should find this volume a valuable addition to their library.

Almost 900 pages, 1953 "Standards on Petroleum Products" is $6 per copy; ASTM members, $4.50. For cloth binding add 65 cents to each of these prices.

Latest Actions of Administrative Committee on Standards

Recommendations Approved from Non-Ferrous Metals, Thermal Insulations, Gaseous Fuels, and Textiles Committees

THE ASTM Administrative Committee on Standards has accepted 13 recommendations submitted by Committees B-2 on Non-Ferrous Metals and Alloys, C-16 on Thermal Insulating Materials, D-3 on Gaseous Fuels, and D-13 on Textile Materials.

Actions taken by the committee and the dates of approval are shown in the accompanying box. The essential features of the new and revised methods and specifications are described briefly in the following summary.

Actions Taken by Administrative Committee on Standards, October 30 and November 9

New Tentatives

Methods of:

Test for Tensile Strength of Wool Fiber Bundles (D 1294 – 53 T) (Approved October 30, 1953)

Test for Recovery of Textile Fabrics from Creasing, Using the Vertical Strip Apparatus (D 1295 – 53 T) (Approved October 30, 1953)

Test for Maturity of Cotton Fibers (Random Sample—Sodium Hydroxide Swelling Method (D 1443 – 53 T) (Approved October 30, 1953)

Test for Cross-Sectional Characteristics of Cotton Fibers (D 1444 – 53 T) (Approved October, 1953)

Test for Strength of Cotton Fibers (Flat Bundle Method) (D 1445 – 53 T) (Approved October 30, 1953)

Test for Number of Neps in Cotton Fibers (D 1446 – 53 T) (Approved October 30, 1953)

Analysis of Carbureted Water Gas by the Mass Spectrometer (D 1302 – 53 T) (Approved November 9, 1953)

Specifications for:

Rosin Flux Cored Solder (B 284 – 53 T) (Approved November 9, 1953)

85 per cent Magnesia Thermal Block Insulation (C 319 – 53 T) (Approved November 9, 1953)

85 per cent Magnesia Thermal Pipe Insulation (C 320 – 53 T) (Approved November 9, 1953)

Revisions of Tentatives

Methods of:

Testing Cotton Fibers (D 414 – 52 T) (Approved October 30, 1953)

Test for Resistance of Textile Materials to Microorganisms (D 684 – 53 T) (Approved October 30, 1953)

Testing and Tolerances for Rayon Tire Cord (F 885 – 53 T) (Approved October 30, 1953)

Non-Ferrous Metals and Alloys

Proposed Tentative Specification for Rosin Flux Cored Solder (B 284) was prepared by Committee B-2 in response to a request from industry for such a specification. It covers cored solder containing specified weight percentages of rosin flux, either plastic, modified, or natural.

Thermal Insulating Materials

Two Tentative Specifications, for 85 per cent Magnesia Thermal Block Insulation (C 319); and for 85 per cent Magnesia Thermal Pipe Insulation (C 320), cover products already covered by Federal Specifications but, as developed by Committee C-16, they are considered to be more representative of actual industrial requirements than the Federal Specifications.

The material described herein is intended for use on surfaces operating at temperatures up to approximately 600 F, the actual temperature limit for specific applications to be mutually agreed upon by the producer and purchaser.

Gaseous Fuels

Because chemical composition represents a major factor in the gaseous fuel field, Committee D-3 undertook the development of standard methods for its determination as one of the main items of its work program. Investigation of the mass spectrometer for analysis purposes produced favorable results and it was decided to prepare methods based on its use. The first of these, for analysis of natural gas, was prepared and is now standard. The committee has now completed Tentative Method of Analysis of Carbureted Water Gas by the Mass Spectrometer (D 1302).

In this method, the molecular species making up a gaseous mixture are ionized and dissociated by electron bombardment, the resulting positive ions of different masses are accelerated in an electric field, separated magnetically, and the abundance of each mass present is recorded. Using the mixture spectrogram thus obtained and the mass spectra of the pure molecular species constituting the mixture, its composition is determined by solving a system of linear simultaneous equations.

Textile Materials

Six new tentative methods and revisions of three existing tentatives, proposed by Committee D-13, have been approved by the Standards Committee.

Two of these tentative methods represent expansion or replacement of tests now appearing in Tentative General Methods of Testing Cotton Fibers (D 414). Tentative Method of Test for Strength of Cotton Fibers (Flat Bundle Method) determines the strength of cotton fibers as a flat bundle and is applicable to loose fibers of untreated cottons whether taken before processing or defibered from a textile product. It replaces the tensile strength test formerly described in Sections 30 to 37 of Method D 414 which is accordingly revised to show this deletion.

D 414 is also revised by the removal of Sections 38 to 43 and substitution of a reference to the new Tentative Method for Determination of Cross-Sectional Characteristics of Cotton Fibers (D 1444). This new method, applicable to samples of loose cotton fibers, raw, processed, or obtained from cotton products, is intended as a research tool for the determination of average diameter and related characteristics of cotton fibers by measurement of the dimensions of cross-sections of individual fibers on enlarged photomicrographs of microtome slices from bundles of fibers. Related characteristics include total cross-sectional area, wall thickness, lumen size, net area, and fiber shape factor.

Also added to Method D 414, following Section 47, is reference to the new Tentative Method of Test for Number of Neps in Cotton Fibers (D 1446). Neps are small clusters of fibers aggregated in a tangled manner with, apparently, a more or less tight core of fibers.

Neps constitute visible imperfections in the textile. They are not to be confused with other structures found in cotton, such as immature seeds or pieces of seed coat covered with fuzz and short fibers.

Tentative Method of Test for Maturity of Cotton Fibers (Random Sample—Sodium Hydroxide Swelling Method (D 1443) is intended for testing cotton fibers in the raw state, processed, or obtained from cotton products. It employs the same conditions and techniques as the array method for swelling and classifying the fibers but it provides an alternate procedure for sampling and for calculating results when length and weight per unit length based on the array method are not required. It is applicable to fibers taken directly from the laboratory test sample.

Tentative Methods of Test for Recovery of Textile Fabrics from Creasing (D 1295) was developed jointly with the American Association of Textile Colorists and Chemists in response to a request from ASA Sectional Committee L22 on Rayon Finished Fabrics. Optimum test conditions of relative humidity, creasing pressure, duration of creasing, and recovery time, for predicting the performance of a fabric in use have not yet been determined. The conditions supplied in these methods are those most widely used at present but are intended only as a guide.

A new Tentative Method of Test for Tensile Strength of Wool Fiber Bundles (D 1294) covers the procedure used in estimating the tensile strength and includes the preparation of the fiber bundle and an appendix for calibration of the tension tester.

The Textile Committee has extensively revised Tentative Methods of Test for Resistance of Textile Materials to Microorganisms (D 684) to bring them up to date and in accordance with current practice. These methods as revised, are applicable to all types of textile materials (loose fiber, yarns, threads, cords, and fabrics) regardless of the kinds of fiber used in their manufacture. Two procedures are presented: Accelerated Fungal Inoculation Method—applicable where storage will be in a damp, warm atmosphere but out of contact with damp soil; and Soil Burial Method—applicable to materials, such as sandbag fabrics, expected to be in contact with damp soil for long periods of time.

Tentative Methods of Testing and Tolerances for Rayon Tire Cord (D 885) were extensively revised at the 1953 Annual Meeting of the Society. Additional changes which were not approved in time to be presented at that meeting have since been completed. These changes apply to the former Section 20, Adjustment of Observed Breaking Strength to 12 per cent Regain Basis, and to former Section 23, Adjustment of Observed Elongation of 12 per cent Regain Basis. These are now Sections 21, 24, and 28 in the Revised Methods in the preprinted 1953 Report of Committee D-13.

Society Participates in Celebration of ASA Thirty-fifth Anniversary

Representatives of the Five Technical Societies and Cooperating Government Departments that Formed ASA Celebrate Founders' Day. Left to right standing: L. C. Beard, Jr., President, ASTM; F. S. Blackall, Jr., President, ASME; T. B. Counselman, AIME; C. W. Bryan, Jr., ASCE; B. H. Gordon, Commerce Dept. Seated: W. W. Milner, Army; W. Howe, Navy; R. E. Gay, President, ASA; C. A. Adams, AIEE.

AN INTERESTING series of meetings was sponsored recently in New York City, by the American Standards Association, as the Fourth National Standardization Conference. It consisted of sessions on Quality Control, Pallets, Industrial Noise, a Panel Discussion entitled "The Purchasing Agent Looks at Standards" and an ASA Member Conference on "Organizing a Company Standards Department." Since the conference was also the Thirty-fifth Annual Meeting, it featured a Founders' Day Session on the opening day, which included greetings from the five societies that had banded together with four Governmental departments to form the forerunner of ASA. ASTM had an important part in this work and the short message given by its President, Dr. L. C. Beard, Jr., appears below.

The participation of the ASTM received most careful consideration in the proposed organization of the American Engineering Standards Committee. It was recognized that the scope and the work of such a coordinating group should stimulate and implement our own as well as all standardization activities,

and so it was in this spirit that ASTM banded with the four other founder societies. Throughout the existence of AESC and its successor in 1927, the ASA, the officers, staff, and members of ASTM have participated very actively in ASA work. Doctor Beard in his message notes the extent of this.

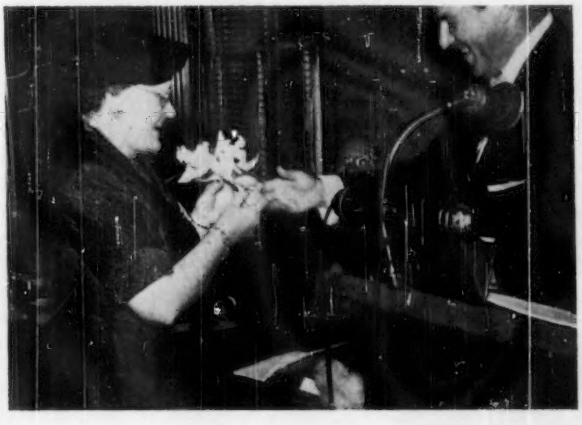
This session was made the more interesting through recognition of a member of the ASTM Staff, Miss Marie Ounan, who, in 1918, transcribed the minutes of the first formal meeting of AESC, taking the dictation from the Society's late Executive Secretary, C. L. Warwick, who was Temporary Secretary of the meeting. In recognition of this, Miss Ounan was greeted by the ASA President, Roger Gay, and received a corsage of orchids.

Following an introductory message by AIEE's Comfort A. Adams, who had headed the preliminary work and was the first AESC Chairman, there were greetings from representatives of the ASCE, ASME, and AIME.

During the session R. C. Sogge, President of the U. S. National Committee of the International Electrotechnical Commission, announced that its 50th Anniversary would be celebrated with an international meeting at the University of Pennsylvania, Philadelphia, September 6 to 16, 1954.

The closing item was a brief report by ASA Managing Director, George F. Hussey, Jr.

Miss Marie A. Ounan, Administrative Assistant, ASTM Staff, receives an orchid from ASA President Roger E. Gay, at ASA Founders' Day meeting.



Dr. Beard, ASTM President, spoke as follows . . .

Thirty-five years ago World War I was drawing to a close and several more weeks will mark the thirty-fifth anniversary of Armistice Day. If we contrast the materiel of war then and now, we get a dramatic picture of the furious pace of our technological development. It was almost prophetic that in October, 1918, a group of far-seeing engineers saw fit to organize the American Engineering Standards Committee. Impetus was given to this by the logistics and materiel problems of World War I. Be that as it may, standardization has usefully served both the civil and military down through the years and will continue to do so.

It is a pleasure and privilege on behalf of the more than 11,000 members and committee members of the American Society for Testing Materials to extend heartiest congratulations and best wishes to the American Standards Association and to all of the men and women who comprise it on its thirty-fifth anniversary.

The ASTM was incorporated in 1902 as a standards-writing and research organization. Obviously, then, it was vitally interested in the proposal first made by the American Institute of Electrical Engineers that there be established some method of coordinating standardization work among the several interested organizations. This Society took a most interested part in establishing on a logical basis the American Standards Engineering Committee, and it has for these thirty-five years participated very actively in many facets of ASA operations.

As of today, about 365 of the some 2000 standards published by ASTM have been accorded recognition through ASA procedures, and we are constantly referring new and revised standards to ASA for approval. Currently, the Society is sole sponsor of five ASA Sectional Committees and joint sponsor with other groups of eight more committees. The Society is represented on upwards of fifty other sectional committees sponsored by other groups. These data speak for themselves; they indicate an intense interest in the work of ASA, and the considerable amount of time and energy devoted by our officers, members, and staff to ASA activities bespeak our support of this vital Association.

Although there was naturally some concern in ASTM councils that organization of another group in the field of standardization might lead to confusion, duplication, and waste of technical talent, it was concluded, that if properly organized, it would serve a very useful purpose and full support was given to this new committee.

One has only to review some of the voluminous correspondence—dusted off and refiled at ASTM Headquarters in the past month—to realize the great seriousness with which this proposal was considered. The file abounds with letters from Comfort A. Adams, Chairman of the Organizing Committee, Edgar Marburg, first Secretary-Treasurer of ASTM, and, of course, reactions of men like A. A. Stevenson, Standard Steel Works; J. A. Capp, General Electric Co.; Henry M. Howe; Mansfield Merriman; A. N. Talbot; William H. Bassett, and others, who had the welfare of ASTM close to their hearts. Their deliberations, resulting in the decision by the ASTM Executive Committee to participate with the other four professional societies, no doubt contributed greatly to the establishment of a sound organization, as attested by the many well-known subsequent accomplishments of the American Standards Association.

The original draft of the organization meeting minutes was prepared by the late C. L. Warwick, then the Assistant Secretary of ASTM, who had taken over the administrative responsibilities with the death of Edgar Marburg, in June, 1918. Later on it was noted in a letter from Professor Warwick, that Professor LePage had accepted appointment as Temporary Secretary of the new committee.

When drafting the minutes, Mr. Warwick told his secretary to number the paragraphs, "Because," he said, "This will probably grow into a big thing." His evaluation was correct, as we can testify here today.

EDITOR'S NOTE.—*At this point in his address Dr. Beard introduced Miss Marie Ounan, who was Mr. Warwick's Secretary, and is now Executive Assistant and Secretary to R. J. Painter, ASTM Executive Secretary.*

Mr. President, may I pledge our continuing active support of the American Standards Association. As our Society continues to expand its research and standardization activities, we shall be bringing new proposals and problems for your study and approval. There is, we believe, a wonderful field of opportunity for ASA in this complex economy of ours. The conservation of our technical talent and the prevention of duplication of effort are today even more pressing than in 1918. We shall attempt to continue in ASTM to do our part in pushing forward the work of the American Standards Association.

ASTM Bulletin

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NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Important Uses of ASTM Standards

New MIT Testing Laboratory Manual

JAMES A. MURRAY, Associate Professor of Materials, Massachusetts Institute of Technology, has written a Manual for the Testing of Masonry Materials. He explains that it is designed for engineering and architecture students, gives them instructions for experience in manipulation and testing needed as background for professional careers, but will not make them skilled laboratory technicians. Their professions require ability and experience in judging—to accept or reject materials—from laboratory reports. Correct judgment will depend on their knowledge, how data have been obtained, and their significance. Murray stresses interpretation of results rather than maximum precision. Interpretation, he writes, can best be made by comparing with the requirements of a specification (and often results depend on all concerned using the same method).

So Professor Murray, to use his views on materials testing, has filled his manual with specifications and tests, practically all of which are ASTM Standards. Of course, he has skillfully modified or abbreviated them for his teaching purpose. Of four meaty chapters—Specifications, Tests, Concrete Mix Design, and Numerous Problems (with answers)—he has devoted the first two, in a way, to ASTM Standards.

Certainly his manual was not written as an advertisement or tribute to the work of ASTM but in a real sense it is just that. Can we point out once more that ASTM Standards are being used as part of the fundamental practical training of the neophyte engineer—even before he finds them part of his everyday, latter-day engineering career?

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and locations of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

DATE	GROUP	PLACE
Jan. 25–27	Committee A-1 on Steel	Pittsburgh, Pa. (William Penn Hotel)
Jan. 27	Philadelphia District Meeting	Philadelphia, Pa. (Poor Richard's Club)
Feb. 1–5	**ASTM Committee Week**	**Washington, D. C. (Shoreham Hotel)**
Feb. 14–19	Committee D-2 on Petroleum Products and Lubricants	Philadelphia, Pa. (Benjamin Franklin Hotel)
Feb. 18–19	Committee D-6 on Paper and Paper Products	New York, N. Y. (ASA Headquarters)
March 6	Committee E-13 on Absorption Spectroscopy	Pittsburgh, Pa. (William Penn Hotel)
March 15–16	Committee D-12 on Soaps and Other Detergents	New York, N. Y. (Penn Sheraton Hotel)
March 17–19	Committee D-15 on Engine Antifreezes	Washington, D. C. (Shoreham Hotel)
March 22–24	Committee D-20 on Plastics	Roanoke, Va. (Hotel Roanoke)
March 24–26	Committee D-9 on Electrical Insulating Materials	Roanoke, Va. (Hotel Roanoke)
June 13–18	**ASTM Annual Meeting**	**Chicago, Ill. (Sherman and Morrison Hotels)**

Society Complimented at ACCL Dinner

DOUGLAS DOW, President of Detroit Testing Laboratory, paid a very nice compliment to the Society during the Men of Science and Industry Dinner sponsored by the American Council of Commercial Laboratories, Inc., in Detroit on November 5. The Society's President, L. C. Beard, was introduced by Mr. Dow, who asked the President to remain standing while he commented about ASTM. Quoting Lord Kelvin's famous statement that when we learn to measure accurately, we will be making progress, he noted that ASTM was rendering real service in providing the yardstick in its tests and standards which enable industry accurately to evaluate the properties and quality of materials. Those at the special table reserved for the ASTM Detroit District were asked to rise, and then Mr. Dow, referring to the significance of ASTM technical committee work, asked all those in the audience who had or were serving on ASTM technical committees to stand. Throughout the large audience and at the speakers' table many men stood.

Many of the members of the ACCL are also affiliated with ASTM, which would be expected from the widespread use made of tests and of specifications in the commercial research and testing work. In addition to participating in technical activities, a number of the men active in ACCL serve in ASTM district work and the secretaries in the Southern California and Cleveland Districts are from leading laboratories in those centers.

The address of the evening was given by Charles R. Sligh, Jr., President of

the National Association of Manufacturers, who stressed the necessity of industry's taking more active part in stimulating education in engineering and science. He also sounded a warning note on a serious increasing lack of venture capital, which is the means of keeping American industry in the forefront with new materials and new developments. He urged everyone present to be a committee of one in helping to remedy the conditions he noted.

Detroit Council Meets with President and Executive Secretary

AT NOON on November 5 President Beard and Executive Secretary Painter had a luncheon meeting with members of the Detroit District Council. Chairman A. J. Herzig, President, Climax Molybdenum Co. of Michigan, Inc., Detroit, Mich., presided. ASTM Vice-President C. H. Fellows, Director, Engineering Laboratory and Research Dept., The Detroit Edison Co., who has been very active in local and national district affairs, introduced the President and Executive Secretary. There was discussion of ASTM activities of interest. Among the current and former district officers present were C. O. Durbin, Chrysler Corp., currently secretary; C. M. Gambrill, Ethyl Corp.; F. F. Zimmerli, Barnes-Gibson-Raymond, Div. of Associated Spring Corp., ASTM director; and W. R. Fraser, Michigan Consolidated Gas Co., past-chairman.

The Society Appoints....

W. H. FINKELDEY, Singmaster & Breyer, to Advisory Committee on Corrosion.

J. H. FOOTE, Commonwealth Associates, Inc., to ASA Standards Council.

J. J. KANTER, Crane Co., to Joint Committee on Definitions of Terms Relating to Heat Treatment, succeeding T. S. Fuller.

F. L. MARSH, National Gypsum Co., to ASA Sectional Committee A 42 on Plastering.

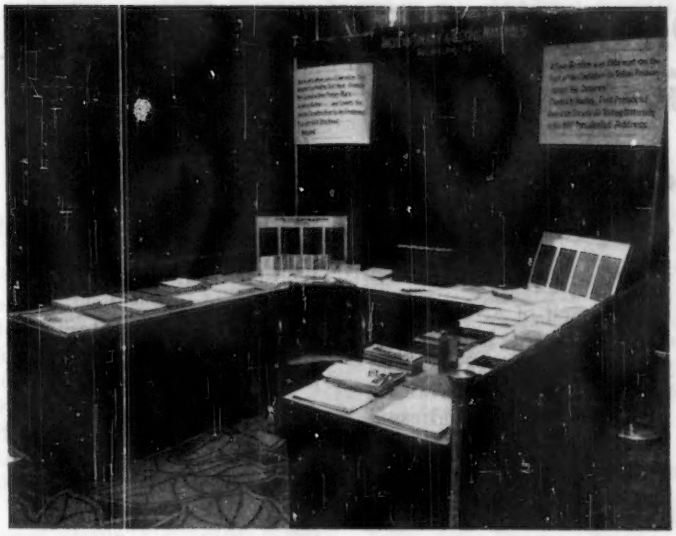
H. M. SMITH, U. S. Bureau of Mines, to ASA Sectional Committee Z11 on Petroleum Products and Lubricants, succeeding T. A. Boyd.

J. C. MOORE and P. J. SMITH to Joint Federation-ASTM Committee on Paint, Varnish, Lacquer, and Related Products.

A. F. TESI, Celanese Corp. of America, to ASA Sectional Committee on Institutional Textiles.

L. H. WINKLER, Bethlehem Steel Co., Inc., to ASA Mechanical Standards Board.

H. R. WOLF, General Motors Corp., to ASA Sectional Committee Z26 on Safety Glass, succeeding H. C. Mougey.



ASTM Book Exhibit at NIGP Conference was of great interest to many delegates. The timely display was the first introduction many of the governmental purchasing agents had to ASTM and its widespread work in the field of materials.

Meeting of the National Institute of Governmental Purchasing Held at Cincinnati

"MORE Value for the Tax Dollar" was the theme of the Eighth Annual Conference and Products Exhibit of the National Institute of Govermental Purchasing at the Netherland Plaza Hotel, Cincinnati, Ohio, Nov. 8–11, 1953.

Featured speakers at two conference luncheons were Edmund F. Mansure, Administrator, General Services Administration, Washington, D. C., and John A. Lloyd, Vice-President of the Union Central Life Insurance Co. of Cincinnati.

The professional program consisted of round-table forums and discussions on the fundamentals of public buying in which all delegates took part. A feature of the Conference was a joint session of public purchasing executives and exhibitors on the subject, "Making It Easier to Do Business with Government." A panel of delegates and exhibitors discussed the simplification of purchasing procedures and the use of standards and specifications developed by industry.

ASTM Standards and Literature were on display in a prominent booth in the exhibit hall and a Staff representative was present to discuss Society activities with the Conference delegates.

The use of ASTM standards in governmental purchasing was mentioned frequently by several speakers.

The NIGP is a nonprofit, educational, and technical organization of governmental buying agencies of the United States and Canada. The basic professional objective of NIGP is to raise the standards of public buying through the interchange of technical and professional information and ideas.

Season's Greetings

and heartiest good wishes for the New Year

ASTM Meeting Places Chosen to 1957

FOLLOWING the forthcoming Annual Meeting in Chicago, Ill., June, 1954, the next three Annual Meetings of the Society will be held in Atlantic City, which, because of its unusually fine facilities for the ASTM type of meeting, has been the scene of so many previous gatherings.

A look ahead also reveals Committee Week locations as follows:

1954—Washington, D. C.
1955—Cincinnati
1956—Buffalo
1957—Philadelphia

That the West Coast has not been overlooked in this scheduling is attested by the fact that the second Pacific Area Meeting is planned for 1956 in Los Angeles, Calif.

District Activities

President Beard "Adds" to East as Marburg Lecturer Makes "Excursion" Through the West

New York

THE first of ASTM President Leslie C. Beard, Jr.'s addresses to the Society's district meetings was held in his "home" district of New York on October 20. Dr. Beard, addressed about 100 chemists and engineers at the meeting sponsored jointly with the American Society of Lubrication Engineers. Hearing his talk "Something Has Been Added" was a distinguished group of guests, among them Past-President K. G. Mackenzie, 1953 Gillett Lecturer Jerome Strauss, Associate Director of the National Bureau of Standards A. T. McPherson, and Lt. Col. E. P. Duque of the Philippine Military Procurement Division.

Pittsburgh

On October 27 Dr. Beard addressed some 140 members and guests of the ASTM and SAE, the societies which co-sponsored the Pittsburgh District meeting. A social hour and dinner at Webster Hall preceded the technical session which was held in the beautifully appointed auditorium of Mellon Institute. It is of interest to note that the local television station took photographs of Dr. Beard, Executive Secretary, R. J. Painter, and the SAE and ASTM local officers for presentation as part of a daily news program sponsored by the Pittsburgh TV station. Among the distinguished guests present were the authority on corrosion, Dr. F. N. Speller, and another of the ASTM Past-Presidents, Dean Harvey.

The third in Dr. Beard's current series of talks was held in Indianapolis on November 6.

Ohio Valley Group Meets in Indianapolis

THIS meeting, sponsored jointly by the Ohio Valley District with the Indianapolis Section of the American Society of Lubrication Engineers was the first held by ASTM in this important industrial center. Much credit for the success of the meeting should go to Griffith Williams, Jr., Process Engineer, Bridgeport Brass Co., who handled all the local arrangements for the district. He was thanked by District Chairman John Pitzer who spoke briefly following some comments by Executive Secretary R. J. Painter. At the Speakers' Table representing the ASLE was Chairman Harkins and Messrs. E. G. Green, Vice-Chairman, and R. C. Fatout, Secretary-Treasurer, Many of the district officers came considerable distances to greet Dr. Beard, including Chairman Pitzer from Cincinnati, Messrs. F. C. Smith, Tube Turns, Inc., A. H. Hurtgen, Henry Vogt Machine Co., District Secretary, W. R. McIntosh, Professor and Head, Department of Civil Engineering, University of Louisville, from Louisville, Ky. Vice-Chairman R. S. Armstrong came from Lima, Ohio, and J. H. Calbeck, former District Vice-Chairman from Columbus.

There was a very interesting discussion period following the President's Address.

Rossini in West and Southwest

WHILE President Beard was addressing ASTM groups in New York, Pittsburgh, and Indianapolis, Dr. Frederick D. Rossini, Silliman Professor and Head of the Department of Chemistry and Director of the Petroleum Research Laboratory at the Carnegie Institute of Technology, was preparing to present a condensed version of his 1953 Marburg Lecture, "An Excursion in Petroleum Chemistry," before groups in Berkeley and Los Angeles, Calif., and Houston, Tex.

The Northern California meeting, at Berkeley, November 12, was a joint meeting with the American Chemical Society, as was the Southern California meeting in Los Angeles on November 13.

The Houston meeting on November 20 was the first meeting held in the newly formed Southwest District. The interest of that group is evident from the large percentage of local members which turned out to hear Dr. Rossini. The ASTM representation was augmented by members and friends of the American Institute of Chemical Engineers, American Chemical Society, and the American Society for Quality Control, which groups co-sponsored the meeting with the ASTM.

Dr. Rossini's address is based on the

At Indianapolis. *Seated,* left to right: President Beard, ASTM; E. Harkins, chairman, ASLE Indianapolis Section; J. C. Pitzer, chairman, ASTM Ohio Valley District; A. Hurtgen, secretary, ASTM Ohio Valley District. *Standing:* R. S. Armstrong, vice chairman, ASTM Ohio Valley District; R. J. Painter, ASTM Executive Secretary; G. Williams, ASTM; E. Green, vice-chairman, ASLE Indianapolis Section; R. Fatout, secretary, ASLE Indianapolis Section.

spectacular and vital accomplishments of the petroleum industry in World War II in supplying for our country's defense, toluene for explosives, components for synthetic rubber, and high-powered aviation fuel, which accomplishments would have been thought humanly impossible one or two decades earlier. Copies of Dr. Rossini's lecture are available in reprint form from ASTM Headquarters.

Silicon Steel Subject of St. Louis Meeting

UPWARD of 100 members and guests attended the ASTM St. Louis District Meeting held on October 15 at the Engineers Club in St. Louis, Mo. This meeting, sponsored jointly with the St. Louis Chapter, ASM, and the Engineers Club of St. Louis, was on the subject, "Silicon Steel." The address by William Jones, Administrative Assistant to Manager, Sales Division, Armco Steel Corp., was well received and stimulated an extensive discussion period.

Mr. Jones, with more than 30 years experience with the Armco Steel Corp. in research, manufacturing, and sales, is well versed on the subject of silicon steel. His address included references to four broad features of this widely used engineering material: (1) the historical background of the development of silicon steel, (2) a description of grades and forms available, (3) applications, and (4) future developments.

New England District Hears Sterner on Trace Chemistry

Materials Research, Standardization, Stressed at Fall Meeting

THE intriguing subject of trace chemistry, or the effects of constituents measured in parts per million—or billion—was presented at the Fall Meeting of the ASTM New England District, October 8, in Cambridge, Mass. Throughout his talk on "The Romance of Trace Chemistry," Dr. John Sterner, Vice-President of Baird Associates, Inc., held the close interest of 75 members and guests.

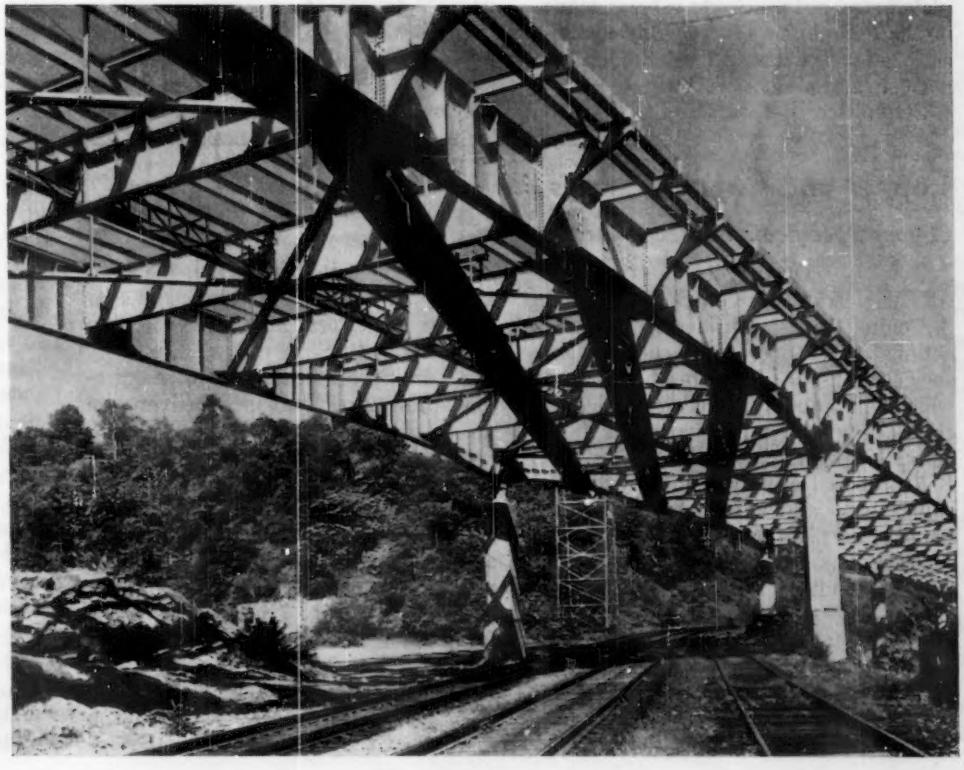
He described numerous examples where minute portions of elements have had pronounced effects. A large diesel engine manufacturer, from constant close control work on oil samples with a spectrograph, can advise a railroad if trouble is brewing and recommend removal of the locomotive from the line. At one point in a magnesium chloride process, some foaming chambers did not function properly because of the accumulation of a few parts per million of boron coming from clamshells used in the process. A concentration of one part fluorine per million parts water has little effect on the teeth apparently. But $2\frac{1}{2}$ parts per million mottles them; 7 to 9 parts per million may stain them brown eventually. Adding about 5 parts per million of copper to food and drink overcame a deficiency causing a licking disease of cattle in Holland.

In trace chemistry, analyses of parts per million (or billion) are dependent on precise techniques of spectrochemistry, the mass spectrometer, and the colorimeter.

Research and Standardization Linked

During a dinner and social hour preceding Dr. Sterner's address, H. H. Lester, New England District Chairman, and R. J. Painter, Executive Secretary, both stressed the importance of materials research in today's world. Dr. Lester thought that we are beginning, at least, to realize the importance of intensive and coordinated research on fundamental properties of materials and on new materials or more efficient uses. He looked upon ASTM as being definitely a materials society and strongly urged that it continue its leadership in research.

Mr. Painter, in citing standardization projects now under way, noted that information on fundamental properties must precede a good specification and that in turn, the research producing the fundamentals is aided by good standards in the form of testing methods.



An important link in the new Schuylkill Expressway, is the 1/2-mile long bridge which spans tracks of the Pennsylvania and Reading Railroads near West Manayunk, Pa. To guard critical members of the structure against damage from corrosive steam ejected by locomotives passing under the bridge, the engineering firm of Michael Baker, Jr., Inc., of Rochester and Harrisburg, Pa., specified, for the Pennsylvania Department of Highways, 1/2-inch wrought iron (ASTM A 42) for the blast protection plates shown in the above progress photograph. Similar safeguard against corrosion is provided by 6-in. wrought iron pipe (ASTM A 72) used in drainage lines of the new bridge.

Technical Committee Notes

Electrical Heating Alloys

New and Revised Specifications in Progress; "Project Tinkertoy" Film at Dinner Session

Progress in development of new specifications and revision of existing specifications was reported at the two-day meetings of Committee B-4, October 8 and 9 in Washington, D. C. Featuring the dinner on Thursday, October 8, was the National Bureau of Standards sound film on the electronics "Project Tinkertoy" which was described by the Bureau's Robert L. Henry, Jr., Chief of the Process Technology Section.

New specifications currently being drafted include one for grid wires for use in electronic tubes. This specification covers molybdenum, tungsten, and five types of nickel alloys. A second specification for tungsten wire (for other than grid use) is limited to a maximum of 20 mils. The third covers molybdenum wire for other than grid wire use and is also limited to 20 mils.

A proposed specification entitled "Clad and Plate Steel Strip for Radio Tubes and Incandescent Lamp Use" will cover nickel-clad steel strip, aluminum-clad steel strip, nickel-steel-aluminum composite strip, and nickel-plated steel strip. Study is being made of the desirability of preparing specifications for nickel strip for cathodes and also for carbonized nickel strip.

Committee B-4, which has participated actively with Committee D-9 on Electrical Insulating Materials on the subject of mica, is now planning similar cooperation with C-21 on Ceramic Whitewares so that effective liaison may be developed to cover electronic needs in the field of ceramics.

The accelerated life test for metallic materials (B 76) which was developed mainly for nickel-chromium and nickel-chromium-iron alloys is being revised so that it will be applicable to aluminum-chromium-iron alloys.

Other work in progress includes continuing study of the flexivity test in connection with thermostat materials, "surety of contact" in the use of contact materials, and collapse strength of cathodes. The work of the analysis section is continuing with the study of vacuum fusion, determination of oxygen and hydrogen, as well as methods for determination of columbium, iron, manganese, and titanium in electronic nickel. Future work will include determinations of aluminum, silicon, and magnesium.

Project Tinkertoy

One of the high lights of the B-4 meeting was the talk and sound film presented at the dinner and technical session on Thursday evening. Robert L. Henry, Jr., Chief of the Process Technology Section of the National Bureau of Standards, spoke on "New Production Methods for Electronics." Mr. Henry outlined the background of modular design and mechanized production of electronics sponsored at the Bureau by the Navy Department of Aeronautics and code-named "Project Tinkertoy." Starting from raw or semiprocessed materials, machines automatically manufacture ceramic materials and adhesive carbon resistors, print conducting circuits, and mount resistors, capacitors, and other miniaturized component parts on standard uniform steatite wafers. The wafers are stacked very much like building blocks to form a module that performs all of the functions of one or more electronic stages. Automatic inspection machines check physical and electrical characteristics of the parts-mounted wafers at numerous stations along the production line. The completed module is a standardized interchangeable subassembly combining all of the requirements of an electronic circuit with ruggedness, reliability, and extreme compactness.

Many of the members of Committee B-4 took advantage of the invitation extended by the Bureau to see this project in operation. This conducted tour for "cleared" members was held after the B-4 meeting on Friday afternoon.

Copper and Copper Alloys

Copper Specifications Ready for Approval

During its meetings at ASTM Headquarters on October 7 and 8, Committee B-5 considered numerous actions on copper and copper-alloy specifications, a large proportion of which will probably be recommended to the Society for final action at its 1954 Annual Meeting.

A proposed classification of wrought copper-base alloys is now ready for ballot in the main committee. Two new specifications are being balloted upon in subcommittee for copper-zinc-manganese alloy (manganese brass) sheet and strip for resistance welding, and for nickel-tin bronze sand castings. The following changes in existing specifications have also been approved for subcommittee letter ballot:

1. In Specification B 122, the committee is adding requirements for another 10 per cent nickel silver in strip form.

2. In Specification B 206, requirements for 12 per cent nickel silver wire are being added.

3. In Specification B 140 for leaded red brass rod, the upper limit of 2.2 per cent for lead content of alloy B is being increased to a new limit of 2.5 per cent and the minimum elongation requirement of sizes up to $\frac{1}{2}$ in. is being decreased from 10 to 7 per cent to allow for present-day practices that provide improved machinability.

4. In Specifications B 96, B 97, B 98, and B 99 for copper-silicon alloys, a number of the alloys listed in the appendices are inactive and are being deleted.

5. In Specification B 152 for copper flat products, indication is to be added that hard temper is commonly supplied only as strip.

6. In Specification B 138 for manganese bronze rod, alloy A, and Specification B 124 for forging rod, alloy No. 4, a minimum manganese limit of 0.05 per cent is being added.

7. In Specification B 133 for copper rod, the tensile requirements for hard-temper copper bar over 0.188 to $\frac{3}{8}$ in. inclusive are being revised to new minimum values of 42,000 psi tensile strength and 12 per cent elongation.

8. In Specification B 187 for copper bus bar, provision for square and rounded corners and rounded edge on material under $\frac{3}{16}$ in. thick is being added.

9. In Specifications B 42, B 68, B 75, and B 88 for copper pipe and tube, the required microscopic examination for cuprous oxide in type DHP copper is superfluous and is being deleted.

10. In Specification B 251 for general requirements for pipe and tube, a new straightness tolerance schedule for short lengths is being added.

11. In Specification B 188 for copper bus tube, the provisions for sampling are being revised to correspond with the bus bar specification B 187 to have sampling proportionate to the number of pieces in a lot.

12. In Specification B 30 for copper-alloy ingot, provision for agreement on sampling is being added where requirements are not covered by ASTM.

The committee is giving continued consideration to some 15 items that had been assigned previously to small task groups in the subcommittees and while no final decision has yet been made, the possibility is good that several will reach final stages in 1954.

One of the chief new items now being actively considered by the committee is whether the General Requirements Specifications B 248, B 249, B 250, and B 251 should be retained or whether the requirements should revert to each of the applicable individual product specifications.

As a result of the discussions at the October 6 and 7 meetings, a half-dozen or more new tasks were assigned to small groups of subcommittee members for preliminary discussions and recommendations to the subcommittees. These will be reported when Committee B-5 holds its next meeting at the 1954 Spring meeting of the Society.

Electrodeposited Metallic Coating

First Symposium Announced; New Work Initiated

Although Committee B-8 has in the past sponsored a number of papers pertaining to the use, application, and evaluation of electrodeposited metallic coatings, the committee is currently planning to sponsor its first symposium in this field, it was announced at the October 13–15 meeting at ASTM Headquarters in Philadelphia. The symposium committee, under the chairmanship of G. A. Lux, Oakite Products, Inc., is scheduling this symposium for January or June, 1955.

Several new sections have been formed to undertake new work or to study the desirability of initiating work in new fields. In Subcommittee IV on Plating Practices a new Section K on Alkaline Cleaning has been established. This section is being headed up by Samuel Spring of the Pennsylvania Salt Manufacturing Co. F. A. Lowenheim, Metal and Thermit Corp., has been made chairman of a task group to study what work should be undertaken in the field of tin and tin-alloy coatings.

As a result of round-robin tests on reproducibility of the salt spray test, it was agreed that the salt spray requirements of Specifications A 166, B 142, B 200, and B 201, nickel and chromium on steel, nickel and chromium on zinc, lead on steel, and chromate finishes on zinc, respectively, should be revised, and a modification of these requirements is currently being drafted. In addition, Specifications B 200 is being revised to include a footnote advising that the use of a copper undercoat improves the corrosion resistance of coatings.

Subcommittee V on Supplementary Treatments for Metallic Coatings has exposed on the Bell Telephone Laboratories roof in New York and at Kure Beach, N. C., a number of outdoor tests in an effort to evaluate the performance of various types of chromate coatings, including plain dip, plain dip irridescent, plain dip olive drab, cronak finish, and electrolytic colorless coatings. A simulated box exposure test is also being made in the warehouse at Kure Beach. Accelerated tests will be made on a similar group of panels in which the panels will be subjected to salt spray, high humidity, hot water, and pressure cooker.

In addition to the above exposure tests, Subcommittee II put on exposure in May and June of this year at Kure Beach, New York City, and Detroit, a third series of copper-nickel-chromium panels which has been designed as Program No. 3. Periodic reports have been appended to the annual B-8 reports indicating the data resulting from the first two programs.

Two new recommended practices are being drafted, one for the preparation of plating on lead which use includes holloware, hardware, and newspaper rolls. The other recommended practice is for the preparation of plating on malleable and gray iron.

The committee noted with interest the publication of the new "Compilation of Standards on Electrodeposited Coatings." This is the first revision of this book since October, 1949, and includes all the specifications and recommended practices developed under the auspices of the committee. The list price is $1.85, but ASTM and AES members may obtain copies at $1.40.

Metal Powders

Progress Reported in Standardization

During the National Metals Congress in Cleveland, ASTM Committee B-9 held a series of meetings on October 20 and 21. Very definite progress in the field of standardization of metal powders and metal powder products was reported.

The Subcommittee on Nomenclature and Technical Data decided to defer any decision with regard to the use of the term "sinterings" because of the objections of the Metal Powder Assn. to this term. The plan to send out a questionnaire through which data are to be collected on the mechanical and physical properties of sintered metal powder structural parts made to Specification B 222 was reviewed and approved.

A method of subsieve particle size testing has been approved by the main committee, but at the session of Subcommittee II on Metal Powders a minor amendment was suggested and approved. The amendment will be submitted to the committee for letter ballot. Among the four methods of chemical analysis of metal powders which had been originally worked out by the MPA two were found to be unsatisfactory, namely, the method for total iron in iron powder and the method for insoluble matter in copper and iron powder. Task groups were appointed to investigate these methods, to perform actual analyses, and to report back to the subcommittee. The cooperative program on a compressibility test is making good progress. From the results of the tests it now appears that a method can be written shortly.

Section III A on Bearings discussed the various modifications that have been suggested for Specifications B 202 for Metal Powder Sintered Bearings (Oil Impregnated). The size list that had been worked out by a task force is not yet entirely satisfactory since it was found that this size list does not agree with the suggested tolerances and press-fits for self lubricating bearings. The task force will continue its work and report at the next meeting. Another task force was appointed to revise the chemical analyses for iron-base bearings, which are no longer considered adequate.

Section III B on Structural Parts has voted an amendment to Specifications B 255 on Bronze Structural Parts which will be submitted to the committee. Also submitted to subcommittee ballot were the specifications for copper infiltrated iron parts, which, with a few minor changes are ready for committee ballot. Task forces for specifications

for porous metal filters and for structural parts from iron and iron-carbon alloys were appointed.

Section III C on Cemented Carbides has approved a recommended practice for hardness testing of cemented carbides which has been passed on to the committee with a few minor changes. A recommended practice for determining the density of cemented carbides will be submitted to subcommittee ballot within a few weeks. A task force was appointed to complete a recommended practice for metallography of cemented carbides, most of this work having been done already in connection with the Tentative Recommended Practice for Determining Porosity (B 276). When this recommended practice on microstructure has been approved by the subcommittee, it will be passed on to ASTM Committee E-4 on Metallography for inclusion in the general standards of preparation of metallographic specimens.

An organization meeting for a group concerned with test methods and specifications for refractory metal powders was very well attended. The general feeling was that this was a good time to start again on work to develop standard methods for testing tungsten and molybdenum powder. William Bleecker of the Cermet Division of Allegheny Ludlum Steel Co. will be chairman of the group. Three task forces were appointed to concern themselves with three methods of particle size determination, namely, the Fisher subsieve sizer, turbidimetric methods, and microscopic method. Those attending the meeting agreed to become Section II B on Refractory Metal Powders of Committee B-9. The former Subcommittee II will become Section II A on Base Metal Powders.

Cement

Portland-Pozzolan Cement Specifications Completed

The acceptance of a proposed specification for portland-pozzolan cement by the Sponsoring Committee on Blended Cements was one of the important actions taken at the October 19–21 meeting of Committee C-1. The Purdue Memorial Union, Purdue University, was the scene of the combined meeting program with Committee C-9 on Concrete and Concrete Aggregates.

The proposed specification, representing considerable study and review by the working group, will be submitted to subcommittee letter ballot. Also considered by the blended cement group was the suggested elimination of the MgO requirement in the Tentative Specification for Portland Blast-Furnace Slag Cement (C 205). Data will be circulated for consideration of the significance of effect of the present 5 per cent limitation.

Further refinements in the apparatus used in the water retention test, as outlined in the Specification for Masonry Cement (C 91), were approved, including a metal perforated dish which is not attacked by masonry mortar. The committee took action to withdraw the Standard Specification for Natural Cement (C 10 – 37), and is recommending the adoption as standard of the Tentative Specification C 10 – 52 which will replace the older standard.

An interesting series of charts was presented before the committee, representing the results of a comparative test series on standard samples on cement, tested by approximately 200 laboratories under the sponsorship of the Cement Reference Laboratory. This information, which will be disseminated to the membership, shows the degree of reproducibility of results on the several test requirements for physical properties and chemical analysis of portland cement.

Further refinements were agreed upon, including initial sampling and control of temperature, in a proposed revision of the tentative calcium sulfate test method (C 265). A complete revision of the Standard Method of Test for Compressive Strength of Hydraulic Cement Mortars (C 109) will be circulated to the committee membership and will be published in the ASTM BULLETIN as information. It is planned to recommend this revision for adoption as standard at the next Annual Meeting of the Society. The Subcommittee on Strength also plans to conduct a cooperative test series to establish a better quartering and sieve analysis procedure.

A cooperative series is under way for determining specific gravity of cement, in which the Standard Method C 188 will be compared with the pycnometer method. The Subcommittee on Bleeding discussed the substitution of the tentative bleeding test (C 243) for the fineness test. No decision was reached in this respect, and meanwhile, round-robin tests have been arranged to establish the precision of the bleeding test when using machine mixing. A significant change, recommended for immediate adoption, was approved in the autoclave expansion test (C 151), whereby $1\frac{1}{2}$ hr will be used in place of 1 hr for the cooling period.

In reviewing the methods for determining time of set, attention was given to the difference between requirements of the Federal Specification and the ASTM methods. A simplification of the Vicat needle test (C 191) is being considered.

The Subcommittee on Chemical Analysis reported progress in the development of the method for the determination of magnesium oxide by flame photometer, and a cooperative investigation of a proposed method is planned.

Dr. Herbert Insley, National Bureau of Standards, Chairman of the Subcommittee on Volume Change, presented an informal talk on reactive aggregates and the effect on the swelling action in mortar. This talk is part of a series to be presented by the working subcommittees on their respective fields. Committee C-1 will meet February 3 and 4 during ASTM Committee Week in Washington, D. C.

It is technology that gives the extra things that count. Industrial technology provides the extra food on the table, the extra mile on the speedometer, the extra dollar in the wallet. It is the extra bushel in the barn, the extra suit in the closet, the extra diploma at commencement time. It is the extra hours of lesiure, the extra years of health and life, the extra measure of security. . . .

We have now opened up a whole new stage for our national development, a stage on which the elements of the land and the people are augmented by a third dimension—the dimension of science. . . .

—HENRY B. DU PONT, Vice-President, E. I. du Pont de Nemours and Co., Inc.

Chemical-Resistant Mortars

Work on Silicate Mortars Renewed

Renewed activity in the field of silicate mortars was reported at the Fall meeting of Committee C-3, held at ASTM Headquarters on November 5. Classification of the several types of silicate mortars will be made, with the subcommittee concentrating on the development of bond, compressive, and tensile strength methods on chemical-setting sodium silicate mortar. The present Tentative Method of Test for Chemical Resistance of Hydraulic-Cement Mortars (C 267) was recommended for adoption as standard at the first opportunity. The Subcommittee on Hydraulic Mortars will also canvass the industry for information on hydraulic cement-latex combinations.

A draft of a proposed method for determining bond strength was reviewed and will now be prepared in final form for submittal to the committee at the next meeting as a proposed tentative method. In the study of working and setting time, a need for definitions of initial setting time, final setting time, and working time was expressed, and efforts will be made to develop these definitions for consideration at the next meeting. The committee will meet in Washington, D. C., on February 5 during ASTM Committee Week.

Concrete and Concrete Aggregates

Specifications for Fly Ash Nearing Completion

The preparation of a tentative specification for fly ash as an admixture in concrete took a major step forward at the Fall meeting of the committee C-9, held at Purdue University on October 21–23, immediately following meetings of Committee C-1 on Cement.

A draft of the proposed specification was reviewed in detail and changes agreed upon by the subcommittee incorporating a maximum ignition loss limit and to cover only one type of fly ash used. The final draft will now be circulated to the subcommittee for letter ballot. Changes in the latest draft of the specification, make it necessary to rewrite the tentative method of test (C 311). This revised method will be presented to the committee simultaneously with the specification.

Significant developments were reported in the study of chemical reactions of aggregates and concrete, and the subcommittee dealing with this subject presented a draft of a proposed tentative method of test for potential volume change of cement-aggregate combinations. In considering the chemical tests in the procedure for testing for potential reactivity of aggregates (C 289), changes were agreed upon in the subcommittee to provide for single point titration for reduction of normality in place of the double end point titration.

Thirty-nine revisions in terminology found in the Tentative Definitions of Terms Relating to Natural Mineral Aggregates (C 294) were approved for letter ballot of the committee. In the study of setting time of concrete, cooperative tests are now in process which will include determinations on tensile strength, the use of the sonoscope, finishing, and penetration. With the acceptance and publication of four methods of freezing-and-thawing tests of concrete, the subcommittee responsible will now undertake a study to establish a relationship between the four methods. The proposed method of test for volume change of concrete products was reviewed and will now be circulated for subcommittee letter ballot. Further study of accelerated soundness tests on concrete aggregate will be made through the circulation of test results from the Bureau of Public Roads.

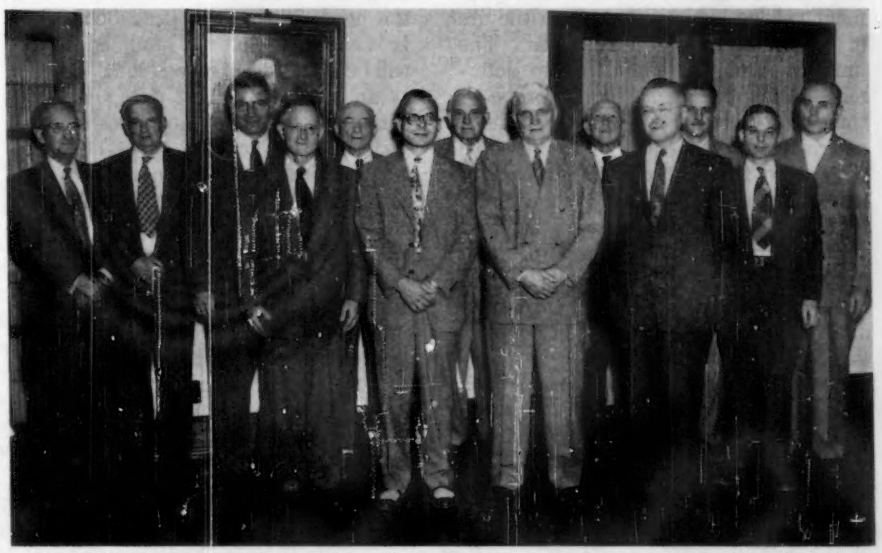
The acceptance by the subcommittee of a proposed specification for lightweight aggregates for use in insulating concrete completed the development of three specifications covering lightweight aggregates. The first two specifications covering structural concrete and concrete units, respectively, are awaiting committee letter ballot.

It was recognized that considerable variation exists in methods of capping concrete cylinders for strength tests, and a study will be made in an attempt to unify this procedure. The effect of rodding of both regular and lightweight concrete is also receiving consideration.

To Prepare New Edition of Significance of Tests

The significance of tests of concrete and concrete aggregates has been covered in a special publication sponsored by Committee C-9. This publication has been very much in demand, and the last edition has now been exhausted. Heeding this demand, the committee accepted a proposed outline for an entirely new edition of this publication. This new edition will be expanded to include the significance of properties, as well as tests, of concrete and concrete aggregates. Suggested authors have been assigned, and the development of this project will proceed rapidly, with the expectation that it may be completed early in 1955.

Committee C-9 will meet on February 1 and 2 in Washington, D. C., during the ASTM Committee Week.



At the C-9 meeting, left to right: R. E. Davis; J. R. Dwyer; K. B. Woods; R. R. Litehiser; A. T. Goldbeck; G. A. Hawkins, Dean, Purdue Engineering College; F. Hubbard; R. B. Wiley, Head, Purdue Civil Engineering; W. C. Hanna; L. W. Teller, chairman; B. Mather; D. W. Lewis; L. C. Gilbert.

Technical Committee Notes

Glass and Glass Products

Proposed Methods Include Softening Point and Linear Expansion

Proposed methods for measuring the softening point of glass and the average linear expansion of glass are among several new methods which will be submitted to the Society by Committee C-14 on Glass and Glass Products it was reported at the Rochester, N. Y., meeting of the committee. The group met on October 8 in advance of the fall meeting of the Glass Division of The American Ceramic Society.

A method for the measurement of strain point and annealing point is also nearing completion, and a second draft will now be prepared.

Good agreement has been reached in round-robin tests using the versene method for the titration of lime and magnesia in the analysis of soda lime glass, as well as with glass sand. Encouraging results were also reported on the development of rapid routine methods for glass sand analysis, one being a colorimetric method for alumina.

The difficult problem of securing a source of standard glass disks for use with the ASTM Standard Method of Polariscopic Examination of Glass Containers (C 148) is nearing solution. It is hoped to have a definite announcement at the time of the next meeting of the committee which will be held during the annual meeting of The American Ceramic Society in Chicago, April, 1954.

Thermal Insulating Materials

Effect of Moisture Research in Progress

The effect of moisture on the performance of insulating materials has been a real problem in the thermal insulating field, and because of its significance, Committee C-16 has sponsored a research program which is being conducted at The Pennsylvania State University. A report of progress was made at the recent meeting of the committee at Williamsburg, Va., on October 26–28. Actual work was started on the research project on August 1, and preliminary tests have established a good portion of the equipment needed, which is based on the use of a thermal conductivity probe. The immediate objectives will be to determine the applicability of the probe to the peculiar needs of the required tests and evaluate the effect of hygroscopic water and free water. Three types of insulation are now being considered, namely, cork board, glass fiber, and vegetable fiberboard. There is still need for additional funds to insure the completion of the research program, and it is expected that further solicitation will be made.

Several proposed specifications for block and pipe insulation were reviewed and accepted in final form. Specifications covering calcium silicate block and pipe insulation, cellular glass, and cork board were approved for letter ballot of the committee. Specifications for diatomaceous earth block and pipe covering insulation respectively, which have already been submitted to committee letter ballot, were reviewed with respect to comments in support of negative votes and will now be submitted to the Society for approval as new tentatives.

The development of a racking load test and a flame resistance test is still receiving primary consideration by the **Subcommittee on Structural Insulating Board.** It is now planned that the existing ASTM Tentative Methods of Conducting Strength Tests of Panels for Building Construction (E 72) will be used as a basis for a modification to fit the needs in the insulating board field. It is expected that the modified method will be added to Methods E 72, possibly as an appendix. Test data, using the flame resistance method prescribed in Federal Specification SS-A-118a, between laboratories have not shown good correlation. It is expected that a joint meeting of task groups of the subcommittees on structural insulating board and on blanket insulation will be held in order to coordinate further the work on a flame resistance test.

A wet adhesion test is being developed for insulating cement, with results reported by several subcommittee members using their own methods. Decision was reached to conduct a round-robin test program, using the Johns-Manville method, which uses a sample, tapered in thickness, on stainless steel. Data are being collected on a proposed plasticity test for insulating cement, with four types of cement being distributed for the purpose of determining proper water ratios. In the field of loose-fill insulation, the subcommittee has completed a round-robin test series for the determination of density.

The **Subcommittee on Thermal Conductivity** reviewed comments received from a letter ballot for a proposed method of determining thermal conductivity of pipe insulation, preparatory to submittal to the Society.

A long-awaited proposed method for measuring specific heat is now ready for subcommittee letter ballot, and it is hoped that this will be cleared in the subcommittee for consideration by the main committee at its next meeting. Other special thermal properties, on which there has been much work accomplished in the development of test methods, include a use-temperature limit, linear shrinkage, and hot-surface performance, all for high-temperature insulations. Final drafts are now being prepared on all three proposed methods for subcommittee letter ballot. Another proposed method that has received considerable attention is that for measuring emissivity. A proposed method embodying the essential features of three currently used methods will be prepared for submittal at the next meeting.

The need for a method of sampling of thermal insulation materials, which can be used with all types, has resulted in the preparation of a proposed method by the **Subcommittee on Dimensional Standards.** This proposed method is now ready for subcommittee letter ballot. A fifth draft of a proposed method for determining water vapor transmission of materials used in building construction was accepted and will now be circulated for subcommittee letter ballot. Transmission limits of vapor barriers for various industrial applications have been under consideration, and results of a round-robin series of permeance tests were reported.

The newest activity, that of determining physical properties of coatings, other than permeance, has received prompt attention by the subcommittee appointed to consider this field. Four laboratories reported on flame propagation tests, using a standard sample consisting of a flat form of insulation. The results of these tests indicate good correlation. New exploratory tests on flame propagation will now be undertaken, using two types of blanket type insulation with a bituminous cut-back coating.

The next meeting of the committee will be during ASTM Committee Week in Washington, D. C., February 1–5.

Ceramic Whiteware

Test Methods for Basic Properties to Go to Society

A number of test methods dealing with the fundamental properties of ceramic whitewares are ready for submittal to the Society, after certain editorial changes are made. These methods which were reported on at a meeting of Committee C-21 at Bedford Springs, Pa., on October 1, include modulus of rupture of fired cast or extruded whiteware products; modulus of elasticity; impact resistance of tableware; and the procedure for determining water absorption, bulk density, apparent porosity, and apparent specific gravity of fired whiteware products. They had been voted upon previously by the committee but were referred back to the subcommittee for consideration of negative comments.

A tentative method of test for the determination of linear thermal expansion by the dilatometer method was distributed to the proper subcommittee for consideration.

Activity was reported in the development of test methods on raw materials. A method of sieve analysis for nonplastic materials has been prepared. Procedures for studying steatite and zirconite were also reported upon as being in progress.

A letter ballot has been completed on an additional list of definitions of terms, as well as revision of existing terms. A complete return of letter ballots was reported and acceptance of 21 terms resulted. These will be submitted to the Society as a revision of the present Tentative Definitions of Terms Relating to Ceramic Whitewares (C 242). Additional groups of definitions are under consideration in the subcommittee, one set dealing with floor and wall tile definitions and the other with various types of decoration and special ceramic ware. There was considerable discussion and ıcern in the Subcommittee on Nomenclature over the present usage of the term "porcelain" in place of "porcelain enamel." Contacts will be made with such authorities as the Federal Trade Commission, American Ceramic Society, and the Porcelain Enamel Inst.

". . . our economy will be a whole lot better off in the long run if we spend less time trying to read the future and more energy trying to make the future."

—Benjamin F. Fairless

Structural Sandwich Construction

Core Tests, Standards, Durability, and Aging Effects Considered

The measurement of the many properties and performance required in materials used in structural sandwich construction is channeled into three phases of activity as reported at the Fall meeting of Committee C-19 which met October 8 and 9 at ASTM Headquarters in Philadelphia. In connection with these three phases, the committee has been active in establishing test methods on core materials as the first phase, and discussion took place on proposed methods to evaluate compressive and shear properties with a decision to circulate the compression test method to a letter ballot of the committee. A heat distortion test method for cores was introduced for consideration.

The second field of activity, dealing with standards on the complete sandwich construction, is concentrated at present on proposed methods of tests for flexure and peel. Proposed methods will be circulated for letter ballot in the very near future. The third phase is that of durability and aging effects. Interest was expressed in establishing weathering panels at the ASTM test sites.

A dinner meeting was held, at which time a paper was presented by W. L. Emerson, Goodyear Aircraft Corp., on the subject of Metal-Honeycomb Sandwich and the Goodyear GA-22A Airplane. The next meeting of the committee will be held during ASTM Committee Week in Washington, D. C., the first week in February, 1954.

Porcelain Enamel

Raw Material and End Product Tests Developed

In reporting on the recent Fall meeting of Committee C-22 on Porcelain Enamel, one is greatly impressed with the extent of activity in developing standard test methods, on raw materials as well as on finished products, in the porcelain enamel field. The committee met at the Research Laboratories of Armco Steel Corp., Middletown, Ohio, on October 27 and 28. Two proposed methods on raw materials closest to completion are the method for water analysis and the clay slump test. It is planned to set up a classification type of standard for water analysis, using reference methods developed by ASTM Committee D-19 on Industrial Water. The clay slump test will not be promulgated as an ASTM tentative because of its lack of significance but will be presented as a suggested method only. A proposed method of test for fusion flow of porcelain enamel frits, using the flow-button procedure, was reviewed and a final draft will be prepared for subcommittee letter ballot. An additional test method under consideration is one for torsion testing.

There are several test methods applying to finished products in varying stages of development, several of which are planned for completion in time for action by the Society at the next Annual Meeting. Two of these methods will measure coefficient of scatter and reflectivity, and will now be prepared in final draft form for subcommittee letter ballot. A research program has been planned to establish data on a tearing test method. Some data have been collected on a proposed sag test, with correlation between laboratories still needed, due mainly to the need for a different type of furnace. Other test methods reported in the process of development include an abrasion test, thickness test, scratch test, continuity of coating, and a metal marking test.

The **Subcc mmittee on Research** reported on the activities of several task groups which have been assigned to specific projects. The study of the short and long-term effects of porcelain enamels and ceramic coatings on low-alloy metals at room temperature and above, will be reorganized with a more specific objective assigned. The study of gloss, particularly as to the possibility of establishing a relationship between the current standard 45-deg method now employed by the industry with 60-deg gloss, has been given to a task group. A third project by this subcommittee will be the compilation of a bibliography of tests covering evaluation of enameling iron, fluidity at enamel temperatures, evaluation of set characteristics of clay, evaluation of water for mill additions, measurement of expansion and contrac-

tion characteristics of enamels, incipient spalling, and tearing.

In line with the policy of the committee to inform and solicit the interest of the entire industry in standardization, a permanent **Subcommittee on Education** was authorized. This subcommittee will endeavor to publicize the activities of the committee in developing standard test methods for establishing quality and performance of porcelain enamels, and ceramic and ceramic-metal coatings for metals. This program was initiated at the 1953 Annual Meeting of the Society by the presentation of the Symposium on Porcelain Enamels and Ceramic Coatings as Engineering Materials, which has now been published. During the two-day meeting, an extensive tour was conducted through the Armco plant, as well as the research laboratories, which proved to be of great interest to the members.

Members of Committee C-22 on Porcelain Enamel at their October meeting at Armco Steel Corp., Middletown, Ohio, Chairman W. N. Harrison, presiding.

Paint, Varnish, Lacquer, and Related Products

Advisory Committee Reviews Subcommittee Work

Organization of a new subcommittee and a survey of the status of work in existing subcommittees occupied the attention of the Advisory Committee, of Committee D-1 at its meeting in Philadelphia on October 2. The new subcommittee will give consideration to the development of methods of test for latex and emulsion paints in view of the increasing use of these types of protective coatings. Reports received from the subcommittees set forth the status of various projects under study, as follows:

The Subcommittee on Drying Oils has completed new Specifications for raw safflower oil. A task group has been appointed to prepare specifications for oiticica oil. Procedures for sampling drying oils are in preparation. Other subjects under study in this subcommittee include iodine value of dehydrated castor oil, specifications for fatty acids used in vehicles for protective coatings, and spectrophotometric analysis of drying oils.

The Subcommittee on Traffic Paint prepared the new Tentative Test for No-Dirt-Retention Time of Traffic Paints (D 1297) recently accepted by the Standards Committee. A proposed method for determining settling properties of traffic paints during storage has been approved by committee letter ballot and certain comments received on the ballot are now under study. In this connection cooperative test data on the settling test will be prepared for publication to provide a background on which this test has been based.

A comparative test for wettability of glass beads and a test for clarity of glass beads have been proposed for study by the subcommittee. A working group has obtained considerable information in an effort to develop a suitable accelerated test for traffic paint durability. Because thick-film smear resistance is becoming increasingly important, work is to be done to establish a suitable test for print or smear resistance on traffic paints of 15 mils wet film thickness.

A revision of the Tentative Method of Test for Kauri-Butanol Value of Hydrocarbon Solvents (D 1133) has been completed by the **Subcommittee on Volatile Solvents for Organic Protective Coatings.**

The Subcommittee on Accelerated Tests for Protective Coatings has prepared a new set of photographic reference standards for evaluating resistance to blistering of paints on metal when subjected to immersion or other exposure to moisture or liquids. These new photographic standards designate frequency as well as size of blisters and will replace those now published in Standard D 714. They are now the subject of letter ballot in the subcommittee. A new working group has been established on light and water exposure tests. A test program using water fog cabinets is in preparation. It was suggested at the Advisory Committee meeting that further work on accelerated tests of coatings on wood was desirable.

New Tentative Methods for Chemical Analysis of White Lead Pigments (D 1301), which include revised procedures for analysis of basic carbonate white lead and basic sulfate white lead, were recently accepted by the Standards Committee. These methods are intended eventually to replace the procedures for these lead pigments in Sections 6 to 18 of the present Tentative Methods D 34.

The Subcommittee on Varnish has a Group on Abrasion Resistance which has work under way on methods to correlate abrasion test with floor exposure to foot traffic. If continued exposure maintains the same degree of correlation, a tentative method for the determination of wear resistance based on a sand or carborundum impingement abrasion test will be prepared. It was proposed that, upon the completion of the work, the results be prepared for publication in the ASTM BULLETIN.

The Working Group on Analysis of

Phthalic Anhydride has under way a round-robin test to study the following four criteria: appearance, color of melt, heat control tests, and solidification point. The Working Group on Color of Transparent Liquids is considering the extension of the tentative chloroplatinate series of standards (revised Sections 5 to 7 on Color of Standard Methods of Testing Varnishes (D 154)) beyond the present Color Standard Number 8.

Cooperative tests on varnish with and without dryers are being performed in accordance with ASTM Method D 154, Method 507.1 in Federal Specification TT-P-141 b, and the preferred method of the cooperator. Cooperative tests are being undertaken by a new group appointed to study acid value. With the accepting at the Annual Meeting of a very important revision of the Tentative Method of Test for Specular Gloss (D 523), prepared by the **Subcommittee on Optical Properties,** the method now covers procedures for comparison of the specular gloss of nonmetallic specimens for glossmeter geometry of 60, 20, and 85 deg. The 60-deg geometry is used in comparing most specimens and for determining whether either the 20- or 85-deg geometry is applicable. The 20-deg geometry is used for comparing specimens having a 60-deg gloss higher than 70. The 85-deg geometry is intended for comparing specimens having a 60-deg gloss lower than 30.

The Working Group on Hiding Power has completed a statistical analysis of its recent cooperative test in which a new proposed method of test was used. Precision within laboratories was good but reproducibility between laboratories was only fair. Lack of uniformity of film application, uncertainty of reflectance measurements and of gallon weight determinations are believed to be responsible for the lack of reproducibility. The proposed method will be improved to correct these deficiencies.

There are five working groups actively engaged in developing methods for color difference measurement using the following instruments: (1) Beckman Spectrophotometer, (2) G.E. Spectrophotometer, (3) Hunter Color Difference Meter, (4) Color Eye, and (5) Colormaster Colorimeter.

The Subcommittee on Resins has completed the following two proposed tentative methods which will be submitted to letter ballot of Committee D-1: (1) gravimetric method for the determination of phthalic anhydride in the presence of interfering substances, and (2) spectrographic method for the analysis of phthalic anhydride in the presence of interfering substances. It is planned to revise the Standard Methods of Test for Phthalic Anhydride Content of Alkyd Resins and Resin Solutions (D 563) to include a gravimetric method suitable where no interfering substances are present, a second gravimetric method where interfering substances are present, and a spectrographic method where interfering substances are present. A preliminary study for determination of maleic anhydride, glycerine, pentaerythritol, and fatty acids in alkyd resins is planned. A proposed method for the determination of total aldehydes, vinyl alcohol, and vinyl acetate in polyvinyl butyral will be circulated to the working group for comment.

The Tentative Method of Test for Specific Viscosity of Vinyl Chloride Polymers (D 1243), recently adopted by Committee D-20 on Plastics, will be submitted to the Working Group on Viscosity to determine its acceptability for testing coating resins.

The Subcommittee on Specifications for Pigments completed the important revision of the Specifications for Magnesium Silicate Pigment (D 605). A cooperative test program is being undertaken to study the test for leafing properties of aluminum pigments. This will result in a revision of the test now in D 480. Work is being undertaken on copper phthalocyanine blue pigments.

The Subcommittee on Printing Inks has completed a new Tentative Method of Test for Fineness of Grind of Printing Inks by the Production Grindometer. After approval by subcommittee letter ballot this will be presented to Committee D-1 at the February meeting.

The Subcommittee on Physical Properties of Materials has groups actively working on the following test methods: oil absorption of pigments, consistency of pastes, adhesion, hardness of organic films, permeability of paint films, fire retardency of paint films, flow properties, and film thickness tests on nonmagnetic bases. A new group is being formed for the purpose of developing a method for specific gravity of paint and paint materials, other than pigments.

The Subcommittee on Cellulosic Coatings and Related Materials prepared the new Tentative Method of Test for Residual Odor of Lacquer Solvents and Diluents (D 1296) which recently was accepted by the Standards Committee. Methods have also been completed for Determining the Effect of Household Staining Agents on Applied Nitrocellulose Clear and Pigmented Finishes, and for Nonvolatile Matter in Lacquer Solvents and Diluents. Certain comments received on the recent D-1 letter ballot are now being studied. Studies are under way on the following new methods: (1) perspiration resistance of lacquers, (2) failure of lacquer finishes on wood by checking due to moisture changes in the wood, (3) water in lacquer solvents and diluents, and (4) alcohol content of methyl isobutyl ketone.

The Subcommittee on Painting of Metals still has in preparation the new methods of classifying ferrous surfaces for painting. At the next meeting it is hoped that photographs of the surfaces involved can be selected.

The group on Method of Preparation of Aluminum and Aluminum Alloys for Painting reported that the various methods of preparation were: (1) mechanical cleaning, (2) solvent cleaning, (3) chemical treatments, and (4) anodic treatments. A Working Group on Method of Preparing Magnesium and Magnesium Alloys for Painting is being organized.

Electrical Insulating Materials

Comprehensive Symposium Planned for 1954

Committee D-9 on Electrical Insulating Materials held its fall meeting at Atlantic City, N. J., on September 29 to October 2 with an attendance of about 110 members and guests. R. F. Field was unanimously elected as an Honorary Member of Committee D-9 in appreciation of his many contributions during his long term of service. Plans were made at the meeting for a Symposium on Temperature Classification of Insulating Materials, to be held at the 1954 Annual Meeting of the Society. The symposium will comprise some 15 papers on the following four general topics: (1) test methods, (2) apparatus and equipment, (3) data on high-temperature insulating of materials, and (4) data on thermal aging of electrical insulation.

It will be based on a sound evaluation of materials in use today and will provide information urgently needed for national defense as well as by industry at large.

Subcommittee XII on Electrical Tests has been especially active. The results of a letter ballot vote were reviewed on the extensively revised Methods of Test for A-C Capacitance, Dielectric Constant, and Loss Characteristics of Insulating Materials (D 150). These methods of test cover procedures for the determination of capacitance, dielectric constant, dissipation factor, loss factor, power factor, phase angle, and loss angle of specimens of electrical insulating materials when the standards used are lumped impedances. The frequency range that can be covered extends from a few cycles to a thousand megacycles. This revision has been under preparation for several years by Section C on Dielectric Loss Characteristics. After inclusion of some editorial changes, the revised methods will be submitted to the Society through the Administrative Committee on Standards for immediate publication as tentative.

A new proposed method of test for dielectric constant and dissipation factor of aviation fuels has been completed and will be published this year as information only. This method provides a suitable procedure for the determination of dielectric constant and dissipation factor of aviation gasolines and jet fuels at frequencies from 25 cps to 1 megacycle per sec and at temperatures from 130 to −65 F. The dielectric constant of aviation fuels is particularly significant in the proper functioning of capacitance-type fuel-quantity indicating gages for aircraft. The gage usually is calibrated for a specific type of fuel. A suitable calibration is most readily achieved by using a test air capacitor of value equal to the calculated value of the capacitance of the sensing capacitor used in the fuel system when filled with fuel. In order to establish a suitable calibration, the dielectric constant of the fuel must be known. Also, the accuracy of fuel-quantity measuring system is a function of dielectric constant uniformity of a given fuel. Aviation fuels normally have low dissipation factors, and a test specimen exhibiting an abnormally high dissipation factor would be suspected of being contaminated.

Work is under way on an extensive revision of the present Tentative Methods of Test for Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies (D 149).

A revision of the Tentative Methods of Testing Hydrocarbon Waxes Used for Electrical Insulation (D 1168) has been approved by letter ballot and will be submitted to the Society through the Standards Committee.

Subcommittee VIII on Insulating Materials, under the chairmanship of H. A. Anderson, Western Electric Co., completed new Specifications for Electrical Insulating Paper (Interlayer Type) which will be issued as tentative. These specifications cover electrical grade unsized, unbleached sulfate papers for use as interlayer insulation in coils, transformers, and similar apparatus. Tissue for the manufacture of capacitors is not included in these specifications. However, specifications for capacitor tissue paper are in preparation. A simpler type of accelerated life test for insulating papers is under study. Round-robin tests were reported on parallel samples of capacitor tissue by eight laboratories. These showed rather poor agreement using the method for water-soluble chlorides in the Appendix to the interlayer type paper specifications. Plans were made to study possible variables in greater detail and to recirculate specimens for chloride, pH, and aqueous conductivity measurements.

A new Section on Treated Papers was authorized to handle review of standards on varnished insulating papers received from ASA Sectional Committee C59 on Electrical Insulating Materials. Additional industry representatives will be added to the committee in handling this assignment.

Subcommittee IV on Insulating Oils reported completion of a test for water content of transformer oil by extraction which is recommended as tentative. The present Tentative Methods of Test for Sludge Formation in Mineral Transformer Oil (D 670) are being revised and separated into two separate methods. The first will cover tests for sludge formation by sludge accumulation, and the second by high-pressure oxidation bomb. The sludge accumulation test is applicable in the evaluation of the sludge-forming tendency in new, mineral transformer oils except those that have been "stabilized" by the addition of retarders, stabilizers, and negative catalysts. It is considered of value in studying the sludge forming propensity of a new grade of mineral transformer oil before commercial application. The high-pressure oxidation test is applicable in the evaluation of the sludge forming tendency in new mineral transformer oil except the so-called highly refined oils of zero or near zero iodine number. Some oils oxidize with great rapidity under the conditions of this test, resulting in rapidly increased temperature and pressure. The testing of highly refined oils whether or not an inhibitor, stabilizer, or negative catalyst is present is not recommended. This test is considered of value in checking the sludge forming characteristics of a standard grade of oil in order to control the continuity of this property from shipment to shipment.

Subcommittee IX on Mica Products reported that a new Section E on High Temperature Classification of Mica had been organized. Revisions were recommended in the Tentative Specifications for Natural Block Mica and Mica Films Suitable for Use in Fixed Mica-Dielectric Capacitors (D 748). This subcommittee is sponsoring papers on heat stability and high-temperature properties of mica as part of the symposium on thermal classification of electrical insulating materials.

Subcommittee I on Insulating Varnishes has been especially active. A number of test methods for silicone varnishes are under development including procedures for such determinations as specific gravity, viscosity, nonvolatile matter, flash point, and dielectric strength. Methods are being studied for other types of varnishes as follows: (1) oxidizing insulating varnish, (2) heat-reactive insulating varnish, and (3) laminating varnishes. Three papers are being sponsored for the symposium in June covering (1) heat aging of insulating varnish, (2) high-temperature characteristics and stability of insulating varnish, and (3) heat stability of silicones.

A two-day meeting of Section E on Electrical Adhesive Tapes, under the chairmanship of Howard Orr, was held in New York City on October 20 and 21. The section reviewed in detail the Specifications for Testing Pressure-Sensitive Adhesive Tapes Used for Electrical Insulation (D 1000). Consideration was given to certain changes and improvements in the present test procedures. The section also reviewed a final draft of Proposed Tentative Methods of Testing Elastomeric Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical Insulation. The methods included procedures for the following. Sampling, Conditioning, Thickness, Breaking Strength, Elongation, and Dielectric Strength. Consideration was also given to test procedures for high-temperature pressure-sensitive electrical tapes.

Shipping Containers

Test of Stacking Performance—A New Project

A task group reported at the meeting of Committee D-10, held October 22–23 in Boston, Mass., the specific phases to be followed in the development of a method of testing stacking performance of shipping containers, which are: (1) to establish testing of stacking performance of nonmetallic, noncylindrical containers; (2) the initial study of the problem in relation to corrugated boxes; (3) future extension of study to other types of wood and fiberboard containers; and (4) the setting up of a satisfactory sampling arrangement.

Continuing with the major objective of the committee, agreed upon at its last meeting, task groups presented reports representing the joint efforts of the three subcommittees on methods of tests, performance standards, and correlation of data. This objective is to establish refinements in the existing test methods in order that a satisfactory degree of reproducibility may be obtained. The task group on the revolving drum test (D 782) has prepared a program to investigate (1) specific construction of the revolving drum, (2) maintenance of the drum, (3) condition of faces, and (4) deflection of faces and baffles.

The task group on the drop tests (D 775, D 997, and D 959) reviewed preliminary instrumented drop tests showing definite differences between steel plate in concrete and concrete floors, when using heavy loads. Further study is needed on the effects of various dropping devices, orientation of container, and friction effect of drop-table leaves. The task group on the vibration test (D 999) is considering the use of standardized hardwood deck boards and front and back stops. Round-robin tests would be conducted using the Two-Way ride recorder to compare vibration results.

Other significant work of the committee is now centering in the Subcommittee on Interior Packing. A series of tests has been completed for a proposed tentative load deflection method to determine energy absorption of cushions. Further round-robin testing will be accomplished in eight cooperating member laboratories using cellulosic material. It was agreed to present this proposed method to the committee for letter ballot. A second revision of the "Bibliography and Abstract of Cushioning Studies" was reviewed with further changes being contemplated. A proposed method of measurement of compression set of cushioning materials, as well as drift tendencies, was discussed, with further revisions being agreed upon, as well as conducting further round-robin testing on four cushioning mediums.

A highly interesting talk centering around the field of taste and odor was presented at the main meeting by Ernest Crocker of Arthur D. Little, Inc., titled "The Role of Research in the Packaging Industry." Following a group luncheon, an inspection trip was conducted through the Dewey and Almy Chemical Co. at Cambridge, Mass.

Textile Materials

Symposium, Papers, New Subcommittee Mark Record-Breaking Meeting

Committee D-13 held a very interesting and productive meeting in New York on October 14 to 16, establishing a new record for attendance of 215 members and 70 visitors for a total registration of 285.

In addition to a symposium and a papers session, the meeting was highlighted by the organization of **Subcommittee A-6 on Warp Knit Fabrics.** This new subcommittee already has three task groups actively at work studying test methods for (1) strength and related properties, (2) dimensional changes (shrinkage), and (3) yield and related properties. The need for work on methods of grading was also discussed, and it was agreed that the first approach should be the collection of information on the history of grading systems including a survey of the technical literature.

Work was also initiated on another new project by the organization of a task group to study test methods for tufted textile fabrics. This will include studies of definitions and nomenclature, colorfastness to light and washing, tuft binding tests, and dimensional stability. The Tufted Textile Manufacturers Assn. is cooperating in this work.

Symposium on Interpretation of Stress-Strain Curves

The Symposium on Interpretation of Stress-Strain Curves for Textile Materials was held following the meeting of **Subcommittee B-1 on Test Methods.** Four papers were presented, as follows:

Definitions of the Terms Used in Calibration of the Stress-Strain Curves—A. G. Scroggie, E. I. du Pont de Nemours & Co., Inc.

The Effect of Temperature on the Stiffness and Relative Recovery Values of Single Filaments—Alexander Brown, Carbide & Carbon Chemicals Co.

Parameters That Can Be Calculated from Stress-Strain Curves—Henry Morgan, Fabric Research Laboratories, Inc.

Stress-Strain Time Relations—R. M. Hoffman, E. I. du Pont de Nemours & Co., Inc.

The symposium presented current information on the latest scientific work in the interpretation of stress-strain curves obtained in testing textiles. The papers pointed out the important uses and potentials of the new types of testing apparatus for obtaining stress-strain diagrams.

Papers Session

The annual Papers Session was sponsored this year by **Subcommittee B-5 on Sampling Presentation and Interpretation of Data.** The following three papers were presented:

Quality Control in Warping Continuous Filament Acetate from Bobbins—L. I. Horner, Celanese Corp. of America

Statistical Comparisons—Simple but Elusive—J. W. Tukey, Princeton University

Interlaboratary Studies—W. J. Youden, National Bureau of Standards

In his paper, Mr. Horner gave examples of improvements in quality that had resulted from simple control practices. For example, breaks per beam in warping decreased 75 per cent. The quality control practices proved valuable because they were kept simple and could be applied quickly. Professor Tukey gave some simple examples for analyzing data with known error risk. Mr. Youden, in his paper, presented examples of economy in operations when using and planning interlaboratory test programs.

Subcommittee Reports

Subcommittee A-7 on Ultimate Consumer Products reported that substantial progress had been made on three of its projects. The first of

these concerns studies of a test method for pilling of textiles. Pilling is the formation of bunches or balls of tangled fabrics on the surface of a fabric. The committee completed interlaboratory tests on seven fabrics of predetermined pilling characteristics tested by nine laboratories in which excellent agreement was reached between laboratories. However, correlation with actual wear experience indicated the need for further development work on the test method. In addition to the duPont Pilling Tester and the Stoll Abrader two new test machines have now been introduced, (1) Appearance Retention Tester and (2) U. S. Testing Pilling Tester. A new test program will now be undertaken in an attempt to determine (*a*) correlation existing among these four methods, (*b*) correlation between each test method and the known pilling characteristics of the test fabrics.

The Task Group on Slide Fasteners (Zippers) has completed a set of definitions and nomenclature which cover the names of zipper parts and apparatus for testing slide fastener performance. Further work is being done on size definitions and testing procedures. In its work the task group has had the close cooperation of the Slide Fasteners Assn. This project has as its objective the definition and improvement of slide fastener quality.

The **Task Group on Elastic Fabrics** presented new methods for tension testing, permanent set, and ultimate elongation on the spring balance type of tester, which will be submitted to letter ballot for approval as tentative. A method for testing these same properties on the incline plane apparatus is now in preparation. Definitions and nomenclature are also ready for letter ballot. Future work of this task group will be devoted to methods for testing rapid oxidation and heat sensitivity of these fabrics. Consideration was also given to the need for methods for discoloration and resistance to dry cleaning.

The **Task Group on Evenness of Yarns** has prepared an extensive report of its preliminary study of yarn evenness testers. This report includes an extensive survey of the literature which comprises some 95 references to papers on all phases of yarn evenness. This report also describes the preliminary study undertaken by the task group for the comparison of yarn evenness testers currently being used by research and control laboratories.

The **Subcommittee on Pile Fabrics (Carpets)** reported completion of a new Test Method for Determination of Tuft Bind of Pile Floor Coverings. This method of test is intended for the determination of the force required to remove a tuft completely in the case of cut pile floor covering or to pull or to snag the loop of a looped pile floor covering. This test method is limited to woven pile floor coverings only. Other work under way in this subcommittee covers tests for moisture content of Kraft cord, insect damage, wear or abrasion by NBS test, flammability, and service properties of pile floor coverings.

Adhesives

Standards Proposals Reach Final Form in Three-Day Meeting

Four new tentatives have been prepared by Committee D-14, it was reported at the three-day October meeting held at Wyandotte Chemicals Corp. in Wyandotte, Mich.

Ready for submittal to the Society are: Method of Testing Adhesives Relative to Their Use as Electrical Insulation; Method of Testing Susceptibility of Adhesives to Rodent Attack; Method of Testing Susceptibility of Adhesives to Vermin Attack; Recommended Practice for Testing Bonded Specimens as Cantilever Beams under Repeated Constant Deflection; and four newly defined terms.

The subcommittees reported their activities at the meeting as follows:

I. **Strength Tests.**—An extensive study is still being made in regard to the production of easily fabricated test adherents for the tension testing of adhesives. These modifications and improvements will eventually be incorporated in the test methods.

II. **Analytical Tests.**—The newest project of this section is a study of all the tests currently used in industry for the determination of solids from urea resins. This project will ultimately result in a method of test for these solids which will be of value throughout the industry.

III. **Tests for Permanency.**—The desirability of having a method which would test the resistance of adhesives to attack by saline waters was discussed. It was felt that the utilization of the salt spray test as described in ASTM Method of Salt Spray Testing (B 117) be incorporated as an additional reagent in Tentative Method of Test for Resistance of Adhesive Bonds to Chemical Reagents (D 896).

IV. **Working Qualities.**—Presently two investigations are under way. One, a detailed study of the critical glue line as a function of gap-filling properties, is of considerable interest and is revealing significant data to the committee. The other study is concerned with establishing a method of determining the viscous flow against setting time as measure of tack, by the use of a "tackmeter."

The subcommittee has two methods in committee ballot: method of test for consistency of adhesives, and method of test of storage and working life of adhesives.

V. **Specifications.**—A comprehensive study is under way in connection with specifications for packaging adhesives. Specifications contemplated in this program include those of bond stability, rate of bond formation and setting time, total solids, and sampling of adhesives.

Growing concern over an acceptable standard for adhesives to be used with fibrous acoustical materials has led the formation of a joint working group of Committee D-14 and Committee D-20 on Plastics. This group, composed of representatives of consumers, producers, and the Federal Government, expects to begin work immediately.

VI. **Nomenclature and Definitions.**—New definitions to be considered for inclusion in the Definition of Terms Relating to Adhesives are: adherence, plasticizer, pseudo-stable, polar adhesive, and nonpolar adhesive.

VII. **Research Problems.**—This subcommittee held an evening meeting at which time the members discussed research problems being investigated in their departments. The discussions were most interesting and informative and tended to point up the fundamental problems to be faced in the future.

The meeting closed after a tour of the Plymouth automobile plant and the Wyandotte Chemicals Corp.'s facilities.

The next meeting will be held in Pittsburgh, Pa., on April 7 to 9, 1954.

Engine Antifreezes

Recommend Submittal of Standards to ASA

Committee D-15 held meetings in Cincinnati, Ohio, on October 7 to 9. **Subcommittee I on Freezing Point Determination** prepared some editorial changes in the Tentative Method of Test for Freezing Point of Aqueous Engine Antifreeze Solution (D 1177) and recommended this method for adoption as an ASTM Standard. It was also recommended that simultaneously with its adoption by the Society the method be submitted to the American Standards Assn. for approval as American Standard.

The **Subcommittee on Physical Properties** reviewed the Standard Methods of Test for Boiling Point of Engine Antifreezes (D 1120) and for Specific Gravity of Concentrated Engine Antifreezes by the Hydrometer (D 1122). It was decided that no further changes were necessary in these methods which had been adopted as standard by the Society this year, and recommendation was made that both of these methods be submitted to the ASA for approval as American Standards.

The Study Group on Glycol Analysis, under **Subcommittee IV on Chemical Properties,** is collecting copies of methods now published for determining glycol. Also, methods being used by various laboratories, which may not be available in published form, are being obtained. These will be examined, and cooperative laboratory studies will be made in order to determine which of the methods shows the best promise.

The Study Group on Detection of Antifreeze in Crankcase Oil is also making the same approach to its assignment. Copies of methods now in use will be obtained and reviewed by the group.

The **Subcommittee on Effect of Antifreeze on Rubber Hose** reviewed the results of recent round-robin tests. Although the results of the collaborative test work has not been too encouraging, there is need for a small scale laboratory test. The subcommittee, accordingly, decided to continue exploring the matter by further cooperative studies.

The **Subcommittee on Simulated and Actual Service Testing** received a report of an investigation of test duration effect on results of the proposed glassware corrosion test procedure. This investigation was carried out by five laboratories who had collaborated in the previous work. Test duration was evaluated at 1, 2, 3, and 4-week corrosion test periods, with separate sets of metal specimens remaining undisturbed (that is, not removed for cleansing) for the entire designated number of weeks in each case. Based on the data obtained, a test period of two weeks (336 hr) was recommended as the optimum duration and is being used in the current cooperative test program.

Plastics

Subcommittees Report Variety of Activities

At its meeting in Atlantic City, N. J., September 28 to 30, Committee D-20 received reports of progress from a number of Subcommittees:

Subcommittee IV on Optical Properties—Color difference measurements, utilizing five different instruments, are progressing. Cooperative tests using the Hunter Color Difference Meter, are nearly complete and a similar study is being made with the IDL Color Eye. Work on haze standards is progressing.

Subcommittee V on Permeance Properties—Interest in a possible method of gas transmission through plastics was discussed and placed under consideration. A questionnaire concerning carbon arc equipment used for accelerated laboratory aging tests is being conducted as a basis for a recommended practice for weather meters.

A revision of the Method of Testing Plastics for Water Absorption (D 570) is being submitted to the Administrative Committee on Standards. A round-robin series of tests is under way to determine the precision of various sized samples for shrinkage measurements.

Subcommittee VI on Specifications—The establishment of two new working groups initiates the work on specifications for polytetrafluorethylene and polymonochlorotrifluoroethylene. A specification for diallylphthalate molding materials has been requested upon consideration of the superior electrical properties of these materials. A round-robin impact testing program on styrene-rubber thermoplastic molding compounds will be initiated this winter.

The preparation of an additional section to the Specifications for Phenolic Molding Compounds (D 700) is under way. This new section will define requirements for rubber, modified phenolic molding materials.

Revision of the Specifications for Cast Methacrylate Plastic Sheets, Rods, Tubes, and Shapes (D 702) is being considered. The new nylon specification has been approved by Committee D-20 letter ballot and is ready for presentation to the Society.

Increasing interest in glass fiber reinforcing materials used in plastics has encouraged the subcommittee to make a recommendation to the Advisory Committee for the establishment of such a section.

Subcommittee VII on Analytical Methods—A method for estimating apparent free phenols in cured phenol-formaldehyde moldings is being initiated. Work is progressing on a method for estimating the volatile content of vinyl chloride polymers, and the test for particle size.

The method for the determination of total chlorine in vinyl chloride polymers has been approved by committee ballot and is being submitted to the Administrative Committee on Standards.

Subcommittee VIII on Research—A program of four papers was presented on the following subjects:

The Control of Weight Uniformity in Glass Mat by Statistical Methods, by G. E. Power, Formica Co.

Prediction of Deflection and Stress Distribution in Beams of Plastics Which Creep, by W. M. Findley, University of Illinois

Measurement of Particle Size Distribution in Vinyl Chloride Resins, by R. M. Berg and W. G. Best, Carbide and Carbon Chemicals Co.

The Potassium Permanganate Test as Applied to Tricresyl Phosphate,[1] by J. E. Caldwell and L. Fowler, Monsanto Chemical Co.

[1] Appears in this issue of the BULLETIN, p. 67.

Subcommittee IX on Molds and Molding—Critical review of the use of the Methods of Measuring Shrinkage from Mold Dimensions (D 551 and D 955) is under way. Studies are also being completed from a round-robin on transfer molds for molding test specimens.

Subcommittee X on Definitions, Nomenclature, and Significance of Tests—Several definitions were brought up for discussion following some negative ballots within the subcommittee. Upon due consideration of the various comments it was voted that these definitions be submitted to letter ballot.

Automotive Rubber

Joint SAE-ASTM Group Holds 65th Meeting

The SAE-ASTM Technical Committee on Automotive Rubber held its 65th meeting in Detroit, Mich., on Sept. 15, 1953.

The **Section on Automotive Vibration Insulators** has under way round-robin tests to determine the reproducibility of the Yerzley oscillograph for testing these rubber parts. The development of a practical test for engine mounts is under study following completion of a questionnaire. Test methods for torsional vibration insulators are also being given consideration.

The brake hose used in conjunction with the new power brakes on passenger cars does not have to be of the same construction as now covered by the present specifications which were prepared primarily for use on trucks, buses, and truck-trailer units. Accordingly, the committee has formulated new specifications covering a light-duty vacuum brakehose. These proposed specifications are now under study.

An immediate letter ballot was authorized on revisions in the Specifications for Rubber and Synthetic Rubber Compounds for Automotive and Aeronautical Applications (ASTM D 735; SAE 10R). These revisions cover changes in the Suffix L requirements for water absorption after 168 hr at 158 F for Class TA (silicones) synthetic rubber compound in Table V. The aging period is being changed from 168 hr at 158 F to 70 hr at 212 F. Also the volume change limit throughout is changed from "+10 per cent" to "+5 per cent" maximum swell. For suffix requirement L, distilled water is used. Increase in volume is determined using the procedure described in Section 9 (*a*) of ASTM Methods D 471 except that the acetone dip is omitted. Change in durometer hardness is determined using the procedure described in Section 10 (*c*) of Methods D 471. The cooling period in fresh distilled water is 30 min and the acetone dip is omitted.

The Section on Static Exposure Testing has undertaken a testing program to investigate factors affecting accuracy of ozone control of laboratory generators. The section received a factual report containing data collected to date on four tests compounds exposed at 18 locations for at least one year. At most locations the samples had been rated weekly for 6-week periods. A method for converting the ratings 0, 1, 2, and 3 observed during the 6 weeks exposure to a single quality retention percentage figure has been proposed. With slight modifications, this recommended procedure for evaluating weather resistance will be given a further trial for the next 6 months to determine its effectiveness.

The **Section on Automotive V-Belts** has prepared revisions of the SAE Standard for V-Belts and Pulleys. These revisions cover the following features: nominal width of groove, new $\frac{33}{32}$ in. size, wall diameters, new top radii, groove depth, and measuring pulleys for conventional belts.

The **Section on Gaskets** is enlarging its personnel to include additional representatives of users and manufacturers of gaskets in view of somewhat broadened scope of activity. A number of important revisions in the Specifications for Non-metallic Gasket Materials for General Automotive and Aeronautical Purposes (ASTM D 1170; SAE 90R) have been approved by letter ballot of the technical committee. Action was taken submitting these to the parent societies for final action.

The new Specifications for Rubber "O" Rings for Seal and Packing Applications, prepared by the **Section on Automotive Oil Seals,** has been approved by letter ballot of the technical committee. Since the material covered by these specifications is used exclusively in automotive applications, it was recommended that the specifications be published only by the SAE. A new Recommended Practice for Bench Leakage Test for Automotive Oil Seals has also been completed and will be published only by the SAE.

Joint Committee Research Panel to Sponsor Fundamental Study of "Creep"

THE outstanding development resulting from the eleventh meeting of the General Research Panel of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals in Cleveland, Ohio, October 19, 1953, was the decision to sponsor fundamental research in the study of creep of metals. Educational institutions engaged in this study are invited to submit proposals for research which will be reviewed by the Panel toward the objective of sponsoring research through graduate fellowships. Inquiries or suggestions concerning this project should be directed to the Chairman, General Research Panel, Dr. A. J. Herzig, President, Climax Molybdenum Co. of Michigan, Inc., 14410 Woodrow Wilson, Detroit 3, Mich.

The General Research Panel is co-sponsoring three symposiums on the effects of temperature on the properties of metals. The first, planned in cooperation with the Gas Turbine Panel, will be held at the 1954 ASTM Annual Meeting in Chicago, and will be a two-session Symposium on Effect of Cyclic Heating and Stressing on Metals at Elevated Temperatures.

A second symposium, sponsored solely by the General Research Panel, is planned for the 1954 ASME meeting in December of that year, or possibly the ASTM 1955 Spring Meeting and is entitled "Basic Effects of Environment on Strength, Scaling, and Embrittlement of Metals at Elevated Temperatures."

The Research Panel has also agreed to sponsor a Symposium on Metallic Materials for Service Above 1600 F during the 1955 ASTM Annual Meeting. The committee for this symposium is under the chairmanship of Dr. V. N. Krivobok, International Nickel Co., 67 Wall St., New York City 5, N. Y. Any offers of papers or suggestions should be directed to Dr. Krivobok's attention. This symposium will be held during the 1955 ASTM Annual Meeting.

The Panel expects to increase materially its research efforts in the future, and some consideration will be given to expanding the present membership. Anyone interested in membership on the General Research Panel of the Joint Committee should submit his qualifications to Dr. Herzig for the Panel's consideration.

The Petroleum Committee in 1953—A Summary

The Year's Activity in the Society's Largest Committee and a Survey of Work Planned in 1954

THE 128-page 1953 Report of Committee D-2 on Petroleum Products and Lubricants was not only the largest report presented to the Society by any of its 74 technical committees, but it also contained the most recommendations (68). These figures reflect considerable activity during the period from June, 1952, to June, 1953, within 26 of the 32 main working groups of the committee.

It would be beyond the scope of this article to list in detail all of the work that has gone on. However, from reports presented to the committee on July 3, 1953, and from the files of the secretary's office, the following summary covering work accomplished from June, 1952, to June, 1953, and work planned for the period June, 1953, to June, 1954, has been prepared.

Technical Committee A on Gasoline

H. M. Smith, chairman. This group annually reviews ASTM D 439, Specifications for Gasoline, as a regular part of its work. During 1953, the committee compared the minimum octane-number requirements for premium-grade fuel in D 439 with the octane number levels for this type of fuel reported in the 1952–1953 Winter National Motor Gasoline Survey. As a result, the minimum research octane number for premium-grade gasolines was raised from 85 to 86.

Section III on Gum and Varnish will continue its study of laboratory gum and varnish tests.

During the year, **Section VII on Storage Stability** completed a preliminary study of the correlation of test results by Method D 525, test for Oxidation Stability of Gasoline, with stability of gasolines that were stored for various lengths of time. As a result of the interest in the phases of the stability problem, Technical Committee A and Research Division V on Analysis of Fuels will be joint sponsors of a Symposium on Gum and Storage Stability of Gasoline which will be held at the February, 1954, meeting of Committee D-2. J. B. Rather, Jr., Socony-Vacuum Oil Co., is symposium chairman. Many producer and consumer members of Technical Committee A are expected to submit papers. Section VII will hold further work on storage stability in abeyance until after the facts and findings of the symposium are completely evaluated. There is feeling within Technical Committee A that some fundamental study on the mechanism of gasoline stability may be needed.

The committee reviewed the liaison with the Federal Specifications Board with reference to Federal Specification VV-M-561 (Gasoline, Automotive/Motor Fuel M). This is a continuing activity of the committee with the purpose of bringing ASTM and Federal specifications for motor gasolines more in line.

Section IV on Sulfur and Corrosion recommended that no test for mercaptan sulfur in gasoline be developed by ASTM at the present time. The section is of the opinion that Method D 130, Free and Corrosive Sulfur in Petroleum Products, gives adequate indication of sulfur corrosion.

Technical Committee B on Lubricating Oils

W. S. James, chairman. This group held a Symposium on Engine Lubrication, July 1, 1953, at the Annual Meeting of the Society. The Symposium consisted of three papers, all of which were well received:

Engine Wear by H. C. Mougey
Bearing Wear by C. Junge
Oil Consumption and Oil Distribution within the Engine by J. P. Hamer, T. S. Tutwiler, and C. A. Weisel.

Section U-III on Industrial Gear Oils has been working on a viscosity classification for industrial gear oils which it expects to submit to Technical Committee B for comment.

Section U-V on Instrument Oils continues to study spreading, corrosion, and oxidation problems in connection with the use of instrument oils.

Section Q-III on Foaming plans a review and redraft of Method D 892, Foaming Characteristics of Crankcase Oils, to improve the repeatability and reproducibility of the method.

The **Subcommittee on Railway Car Journal Lubrication** will continue an active test program to evaluate the extreme pressure characteristics of railway car journal oils with and without EP additives. Both laboratory and full-scale tests are under way.

Technical Committee C on Turbine Oils

F. C. Linn, chairman. The several sections are quite active as indicated by the following:

Section I on Oil Systems of Turbines, which also functions as a joint ASME-ASTM Committee on Turbine Lubrication, wrote proposed recommended practices for the design of turbine lubricating systems, which will be submitted to Technical Committee C.

Section II on Rusting prepared revisions to Method D 665, Rust-Preventing Characteristics of Steam Turbine Oils in the Presence of Water, which amplify the procedure for accepting or rejecting the steel specimens used in the test. The section studied reports of rusting in smaller turbines—marine and other propulsion turbines, and turbine units under 2000 kw—above the oil levels of these turbines. The problem of combating rusting was referred to Section I, which will consider the preparation of suitable recommendations for design and operation of lubricating systems in smaller turbines.

Section III on Oxidation of Turbine Oils proposed revisions to Method D 943, Oxidation Characteristics of Inhibited Steam Turbine Oils, which clarify types of catalyst to be used and permit the use of a low metalloid steel wire as the catalyst conforming to ASTM Specifications A 129, type C.

Method D 157, Steam Emulsion of Lubricating Oils, is undergoing revision in **Section IV on Emulsion Tests.** The section hopes to be able to submit a revised method to Technical Committee C within the next year.

Committee D-2 will co-sponsor a paper on *The Development and Application of Anti-Wear Turbine Oils* by Havely and Black at the 1953 annual meeting of the ASME.

The program to develop short-time oxidation tests for turbine oils is continuing.

Technical Committee E on Burner Fuel Oils

Gilbert Wolter, chairman. Renewed activity on problems relating to burner fuels is planned.

Technical Committee F on Diesel Fuels

W. K. Simpson, chairman. Under continuing review is D 975, Classification of Diesel Fuel Oils, to insure that the classification reflects fuel oil requirements of present-day diesel engines. During 1953 the classification was revised to clarify copper-strip corrosion and pour-point requirements.

At the request of Technical Committee, F, **Section D on Cloud and Pour Points** of Research Division VII plans a study of possible ways to differentiate wax cloud point from moisture or water cloud point of diesel fuels.

An informal symposium on diesel fuels is planned for presentation at the February, 1954, meeting of Committee D-2. W. K. Simpson, General Motors Corp., is symposium chairman.

Technical Committee G on Lubricating Grease

J. M. Bryant, chairman. Concrete evidences of a year of vigorous activity were the proposals of four new tentative methods and one method for publication as information. The new tentatives provide methods of test for the effect of grease on copper (D 1261); leakage tendencies of automotive wheel bearing greases (D 1263); water washout characteristics of lubricating greases (D 1264) and lead in new and used greases (D 1262). The method published as information is for determination of functional life of ball-bearing greases.

A new subsection was established in **Section III on Functional Tests for Lubricating Grease** to investigate the compatibility of lubricating greases. The section also set up a study group to define the problem or factors involved when greases break down or become "thin" in service.

The April, 1953, ASTM BULLETIN contained a report, compiled by **Section IV,** on a long-term study of thixotropic properties of lubricating greases. The section, recently renamed **Lubricating Grease Research Techniques Section,** plans a study of the factors affecting storage stability of lubricating greases.

Technical Committee H on Light Hydrocarbons

C. M. Heinen, chairman. The accomplishments of an ambitious program of work resulted in approval of three new ASTM Standards, D 1024, Butadiene Dimer in Polymerization-Grade Butadiene; D 1088, Boiling Point Range of Polymerization-Grade Butadiene; and D 1089, Carbonyl Content of Butadiene.

New tentative methods for vapor pressure and combined sulfur in liquefied petroleum gas, and for unsaturated hydrocarbons in cracked gases were approved. The methods were jointly developed by Technical Committee H and Research Divisions VIII, III, and IV, respectively.

Method D 1021, Oxygen in Butadiene Vapors (Manganous Hydroxide Method), was revised to explain the agitation procedure, to give new statement of precision, and to correct previous errors.

Section I on Chemical Utilization is considering recommending Methods D 1021; D 1022, Peroxide in Butadiene; and D 1157, Total Inhibitor Content of Butadiene, for adoption as ASTM Standards.

Section II on Liquefied Petroleum Gas will continue study of other methods for testing LPG such as weathering tests, corrosion tests, moisture and specific gravity tests, with an eye to their standardization by ASTM at some future time.

A Symposium on Test Methods for Liquefied Petroleum Gas will be held on September 27 and 28, 1954, in St. Louis, Mo., under the sponsorship of ASTM Committee D-2 and Committee D-3 on Gaseous Fuels; the Natural Gasoline Assn. of America, and the California Natural Gasoline Assn. B. J. Heinrich, Phillips Petroleum Co., is the symposium chairman.

The NGAA Weathering Test for Liquefied Petroleum Gas Butane was written in ASTM form and published as information in 1953.

Technical Committee J on Aviation Fuels

J. T. Hendren, chairman. This committee continued its review of D 910, Specifications for Aviation Gasolines. This vigilance is to insure that the specifications are in line with the requirements of modern-day reciprocating aircraft engines. After over four years of detailed study, the committee proposed revisions to Specifications D 910 that provide for a new grade of aviation gasoline, grade 108-135. The new grade will be colored brown.

Section VII on Jet Fuels continues to be very active, reflecting the increasing importance of jet fuels in our present-day economy. The section has recently developed a laboratory test for jet fuel filterability that was turned over to the Military for further testing on a larger scale. A test for smoke point of jet fuels has been developed and passed on to the NACA and the Military. This method will be considered for standardization by the ASTM next year.

The final report and recommendations of the Armed Service Industry Cooperative Group on Fuel Rating were discussed by Technical Committee J. The report will be studied by a special joint committee composed of representatives from Technical Committee J and Research Division I on Combustion Characteristics. The joint committee will make recommendations on how the findings shall be applied to existing ASTM Knock Test Methods.

Technical Committee K on Cutting Fluids

E. M. Kipp, chairman. Work continues on problems that arise when modern machining and cutting processes are combined with the many types of cutting fluids available.

Section I on Laboratory Evaluation of Cutting Fluids plans to submit a paper for publication in the ASTM BULLETIN summarizing results of examination of a number of sulfurized cutting oils. The oils were examined by the procedure for active sulfur content given in Federal Specification VV-O-283, Determination of Active Sulfur in Cutting Oils.

Work will continue on development of a laboratory film strength test for cutting fluids. Cooperative tests of three representative cutting fluids by uniform procedure using two testers, Timken and Falex, are planned.

A summary report will be prepared covering the two series of tests employing flank wear and finish properties to evaluate cutting fluids. Additional work to improve the precision of the procedure is also planned.

During the year, a series of soluble oils was evaluated by two procedures to determine the stability of water emulsions, and the rust-protective characteristics of water emulsions of the oils. Further cooperative work will be done to improve the procedure for rust-protective characteristics. The emulsion stability method will be recommended for publication as information.

Section II on Plant Evaluation of Cutting Fluids will concentrate its work on improvements of a prospective lathe-turning test to evaluate cutting fluids.

Technical Committee M on Petroleum Wax

W. J. Yates, secretary. This group functions as a joint committee with the Technical Association of the Pulp and Paper Industry. Although it is the newest Technical Committee on Committee D-2, it has eight sections actively at work developing new proce-

dures and adapting existing procedures for measuring the functional properties of wax.

Section I on Strength Tests is attempting to resolve the question of wax molds to be used before the Proposed Test for Tensile Strength of Paraffin Wax is recommended as an ASTM tentative method.

More work is envisioned on effects of humidity, temperature, and mold release compounds on tensile strength measurements and a study will be made to find a suitable bending-type test for paraffin wax.

Section II on Flow Tests modified ASTM Method D 5, Penetration of Bituminous Materials, to test waxes of penetration below 50, and submitted the modification to TAPPI. Plans include publication of the method as information by ASTM.

Section III on Stability Tests is continuing work on an accelerated oxygen-stability test and a peroxide number test.

Study of methods for determining the odor of wax and of classifying the different odors encountered are continuing in **Section IV on Sensory Tests.**

Section V on Composition revised ASTM Method D 721, Oil Content of Paraffin Wax, to extend the procedure to microcrystalline wax and to improve its precision section. TAPPI also plans to publish the method as tentative.

More facts will be gathered regarding the need for a stirring operation in ASTM Method D 87, Melting Point of Paraffin Wax. Attempts will be made to reconcile differences between Institute of Petroleum (London) and ASTM melting point methods.

Section VI on Blocking Temperature, VII on Sealing Strength, and **VIII on Scuff and Gloss** are actively working to develop methods suitable for standardization by ASTM and TAPPI. In the meantime, the methods currently under study by Sections VI and VII will be published by TAPPI as suggested methods because they are considered the most satisfactory methods available at present.

Research Division I on Combustion Characteristics

F. C. Burk, chairman. The committee completed an active year of work aimed at keeping the ASTM engine test methods for rating fuels in line with latest advances in the art of knock testing and studied the development of improved methods.

The two standards for Knock Characteristics of Motor Fuels, the Motor Method D 357 and the Research Method D 908, were revised to eliminate the bouncing pin as authorized equipment. The date for elimination is January 1, 1954.

A series of tests at the Altitude Chamber, National Bureau of Standards, was completed. It was designed to develop precise charts for correcting changes in knock ratings by Methods D 357 and D 908 caused by variations in barometric pressure. The charts are based on a temperature-density concept that is being tried out by the division. Other means of eliminating the effects of barometric pressure on fuel rating, such as fuel injection, were investigated.

Further work will include a program to apply the findings of the above tests at the Bureau, and to decide the need for additional work.

Progress was made in the development of new engine check fuels, composed of pure hydrocarbons, for motor and aviation knock test methods. This work will continue.

A micro method test procedure for determining small differences in antiknock quality of primary reference fuel is being studied. Data collected recently will be analyzed statistically to determine the reliability of the technique in assessing the influence of impurities on the antiknock ratings of *iso*octane and *n*-heptane. Work with the technique will continue.

Efforts to improve instrumentation of the Cetane Method D 613 and the Supercharge Method D 909 are continuing.

Investigations of the Reproducibility of Rating by Motor D 357 and Research D 908 methods at octane levels from 100 up to *iso*octane plus 3 ml TEL per gal, will be continued.

An article summarizing fuel ratings from 1947 to 1952 will be written.

Division II on Measurement and Sampling

L. C. Burroughs, chairman. The ASTM-IP Petroleum Measurement Tables were recommended for adoption as ASTM and American Standards.

The second edition of the ASTM Manual on Measurement and Sampling of Petroleum and Petroleum Products was published in March, 1953. The manual is a compilation of ASTM methods used in the measuring and sampling of petroleum and its products.

D 1220 – 52 T, Manual on Tank Calibration, which contains standard procedures for calibrating upright cylindrical tanks, will be available in December 1953.

Methods for sampling liquefied petroleum gases and electrical insulating oils were removed from D 270, Sampling Petroleum and Petroleum Products. A new Method D 1265, for Sampling Liquefied Petroleum Gases was written, under joint jurisdiction with Committee D-3 on Gaseous Fuels.

During the coming year the division will review existing methods under its jurisdiction and make

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recommendations for their improvement. Other interesting projects include an investigation of automatic devices for sampling, gaging, and temperature determination; preparation of a manual on calibration of spheres, spheroids, horizontal steel tanks (both mobile and stationary) barges, ships' cargo tanks, tank cars, and tank trucks; study of gaging procedures for new tank designs; measurement of wax shipments by tank car; and determination of specific gravity of liquefied petroleum gases.

Reprints of separate tables from the ASTM-IP Petroleum Measurement Tables are now available from ASTM Headquarters. New tables will be studied.

Close cooperation with the American Petroleum Institute and the Institute of Petroleum (London), a feature of recent work, will be continued on methods for measurement and sampling.

Research Division III on Elemental Analysis

C. M. Gambrill, chairman. Eight sections and six subsections are engaged in an extensive program of work aimed at producing better test methods for sulfur, chlorine, phosphorus, metals, ash, carbon, hydrogen, and oxygen in petroleum products.

A new **Section H on Ash Determination** was formed and will be responsible for ASTM Methods D 482, D 874, and those portions of D 810 and D 811 which relate to ash. The section plans to clarify these procedures and to eliminate duplication in their scopes.

Section A on Sulfur completed the new Method D 1266, Test for Combined Sulfur in Liquefied Petroleum Gases by the CO_2-O_2 Lamp Apparatus. If needed by Technical Committee H work will be undertaken aimed at finding a suitable method to determine elemental sulfur in liquefied petroleum gases.

Comparison of cooperative test results using three methods for mercaptan sulfur in jet fuels—Method D 1219 (color-indicator), Shell potentiometric method, and the Phillips amperometric method—showed no essential differences between the methods.

During the year the section will study rapid combustion methods for the determination of sulfur in lubricating oils and heavy fuel oils. Lamps that will burn aromatic concentrates without dilution will also be studied.

Section B on Chlorine was responsible for recommending a sodium alcoholate volumetric method for chlorine in lubricating oils, which was published as information. The method is based on IP 118/48, and offers advantages in simplicity of procedure and, for certain types of samples, reliability of results compared to D 808.

Section C on Phosphorus plans to rewrite the precision section of Method D 1091, Phosphorus in Lubricating Oils, Lubricating Oil Additives and Their Concentrates, and to recommend the method as standard.

Section D on Metals completed work on a test for lead in new and used greases which was approved as tentative.

The section has an active program under way to find the best flame photometric methods for barium and calcium; polarographic methods for zinc; and "Versenate" methods for barium, calcium, magnesium, and zinc.

Section E on Trace Elements completed a flame photometric method for sodium in residual fuels, which was published as information. The section plans review and editorial revision in this method prior to recommending it as tentative. Flame photometer procedures employing direct atomization of residual fuel will be studied.

Two fuel samples will be cooperatively tested for sodium and vanadium by spectrographic methods agreed upon by the section.

Another subject under study is the determination of wear metals in used diesel lubricating oils by spectrographic analysis. Cooperative test results on six used oils will be evaluated. Sampling procedures for used diesel locomotive crankcase oils will be studied. The program is continuing.

A method of test for calorimetric determination of vanadium will be evaluated.

Section F on Tetraethyllead revised Method D 526, Tetraethyllead in Gasoline, to improve the precision section; to permit reporting in milliliters per Imperial gallon and milliliters per liter; and to improve the oxidation step. The polarographic procedure for tetraethyllead in gasoline, published as information in 1952, was made a tentative. Work will be done to improve both TEL methods; and other instrumental methods will be investigated.

Section G on Carbon, Hydrogen, and Oxygen found that the presence of sulfur and chlorine did not significantly affect results by D 1018, Hydrogen in Petroleum Fractions by the Lamp Method.

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Research Division IV on Hydrocarbon Analysis

S. S. Kurtz, Jr., chairman. A new section, G, will develop plans for an ASTM Manual on Hydrocarbon Type Analysis. The manual will contain existing ASTM methods for hydrocarbon type analysis plus additional related material.

The Division developed the new Method D 1268, for unsaturated light hydrocarbons.

As a result of review of existing standards under its jurisdiction, the Division rewrote Method D 875, Olefins and Aromatics in Petroleum Distillates, to delete the description of the bromine number and total acid absorbables; and revised Method D 611, Aniline Point and Mixed Aniline Point of Petroleum Products and Hydrocarbon Solvents. Method D 1017, Benzene and Toluene by Ultraviolet Spectrophotometry was revised editorially.

Methods for conjugated diolefins in hydrocarbon mixtures, for bromine number of propylene and butylene polymers, and for compound types in gasoline distillates by mass spectrometry are under study.

The test for hydrocarbon types in jet propulsion fuels—published as information in 1952—will be revised and expanded. It is hoped that the method can be applied to light distillate products other than jet fuels.

Two methods are nearing completion: Test for Individual Hydrocarbons in C4 Fraction (Infrared Spectrophotometric Method); and Benzene, Toluene, Ethylbenzene, and the Xylenes by Infrared Spectroscopy.

A test program is contemplated to learn more about effects of impurities in ASTM reference fuels (*iso*octane and *n*-heptane) on octane-number determinations.

Research Division V on Analysis of Fuels

C. A. Neusbaum, chairman. The Division will be joint sponsors (with Technical Committee A on Gasoline) of the Symposium on Gum and Storage Stability Characteristics of Motor Gasoline. (See Technical Committee A.)

A revision of Method D 873, Oxidation Stability of Aviation Gasoline, is being prepared which will expand the test to include aircraft turbine and jet engine fuels.

Method D 381, Existent Gum in Fuels by Jet Evaporation, is being cooperatively tested to extend the test to cover diesel fuels.

The proposed test for water in petroleum products and other bituminous materials was republished as information with modifications of apparatus.

A cooperative study on procedures for evaluating gum in lubricated gasolines has been completed and may result in a recommendation to change the procedure in Method D 381.

Research Division VI on Analysis of Lubricants

J. B. Rather, Jr., chairman. Revisions to Method D 974, Neutralization Value (Acid and Base Numbers) by Color-Indicator Titration, which clarify the use of blanks, the procedure for strong base number, and the calculations necessary have been prepared. Studies are continuing concerned with clarifying the field of application of the two Saponification Methods D 94 and D 939.

The application of Method D 974 to materials having a neutralization number of 0.10 or less is being studied. If Technical Committees B, C, and K require a method for neutralization number at the 0.10 level, a cooperative program will be undertaken to revise the precision section of the method in the low range of neutralization numbers.

Studies have been made of a centrifuge method for asphaltenes in unused lubricating oils containing residual stocks using as the solvent a blend of *n*-heptane and cyclohexane. This blend was tried to determine if more uniform precipitation was possible than that obtained with ASTM precipitation naphtha. The merits of *n*-heptane alone may be investigated. Plans for future work include studies of modified procedures to eliminate precipitation of wax and petrolatum when determining asphaltenes.

A cooperative test program to improve the correlation of the Ramsbottom (D 524) and Conradson (D 189) carbon residue methods for samples containing carbon residues of 10 to 20 per cent by weight revealed inconclusive results. Experimental work will be continued to find the basic variables responsible for the erratic results. Coal analysis procedure for "fixed carbon" was studied as a possible solution.

Research Division VII on Flow Properties

J. C. Geniesse, chairman. ASTM viscosity methods and tables D 445, D 446, D 666, and D 567 were brought into line with a new value for the viscosity of water—1.0019 centipoises at 20 C—which was put into effect on July 1, 1953, by the National Bureau of Standards.

The Society published the "ASTM Viscosity Tables for Kinematic Viscosity Conversions and Viscosity Index Calculations" (*STP 43 A*), which was prepared by the Division. The pamphlet contains conversion tables of kinematic viscosity to Saybolt universal and furol viscosities; tables of basic values for calculating viscosity indices from kinematic and Saybolt viscosities; and a table of conversion factors—kinematic viscosity to Saybolt universal viscosity at temperatures from −100 to +500 F. All material in these new ASTM Viscosity Tables is in line with the new NBS value for the viscosity of water.

Work is under way to prepare a new set of Viscosity-Index Tables calculated from basic kinematic viscosity values to replace the Standard Oil Development Co. tables. These new V.I. Tables will comprise a book of about 830 pages and will cover V.I. values calculated from kinematic viscosities over the range of 2 to 75 centistokes at 210 F. The new tables will be published in 1954.

Section D on Cloud and Pour Points is undertaking work along four lines: (1) development of an accurate method for measuring cloud point of diesel fuels, (2) development of an improved method for measuring the stable pour point of motor oils, (3) standardization of pour test equipment, and (4) development of a test for pumpability of residual fuels.

Research Division VIII on Volatility

G. G. Lamb, chairman. Revisions to Methods D 86, Distillation of Gasoline, Naphtha, Kerosine and Similar Petroleum Products; D 216, Distillation of Natural Gasoline; and D 158, Distillation of Gas, Oil, and Similar Distillate Fuel Oils were completed. Revisions include provisions under which thermometers meeting Institute of Petroleum (London) requirements may be used, a more realistic specification for condenser tubing, a more restricted bath temperature for products above 9.5 lb rvp (D 86 only), revision of definition and procedures for recovery and loss (D 216, D 86), provision for inclusion of dry point in D 86 for certain products, and inclusion of a formula for correcting abnormal distillation losses due to low barometric pressure (D 86, D 216).

A cooperative experimental distillation project is being carried out by 37 laboratories to evaluate the 125-ml distillation flask.

Revisions to ASTM flash point Methods D 56, Tag closed tester, and D 93, Pensky-Martens closed tester,

In the interest of cooperation between Britain's Institute of Petroleum and ASTM, Fred D. Tuemmler, Head, Analytical Standardization Dept., Shell Development Co., and chairman of the Coordinating Div. of Test Methods of ASTM Committee D-2 on Petroleum Products and Lubricants, spent two weeks in England discussing the many topics of interest to both organizations. Dr. Tuemmler met many members of the IP's Standardization Committee, some of whom are shown here, left to right: F. L. Garton, chairman; Dr. Tuemmler; W. H. Thomas, deputy chairman; H. Hyams, vice-president of IP.

are planned to put the methods in presently accepted format.

Method D 285, Distillation of Crude Petroleum, is undergoing extensive editorial revision.

The Division cooperated with Technical Committee H on development of the new Method D 1267, for Vapor Pressure of Liquefied Petroleum Gas.

The proposed test for vapor pressure of petroleum products, published as information in 1952, is being studied. Efforts are centered around improving the null point pressure transmitter designed to substitute for the Bourdon type gages specified in Method D 323, Vapor Pressure of Petroleum Products (Reid Method).

Studies are continuing that are aimed at finding out whether a vacuum-jacketed column and mantle type heater can improve the precision of Method D 1160, Reduced Pressure Distillation of Petroleum Products, when substituted for present equipment. Some decision as to method and equipment changes is expected during the coming year.

Data on reduced-pressure distillation will be supplied for the American Petroleum Institute-sponsored project on vapor pressure-temperature relationships at Northwestern Technological Institute.

Research Division IX on Color

H. M. Hancock, chairman. Method D 156, Color of Refined Petroleum Oil by Means of Saybolt Chromometer, was revised and edited into current format. More specific requirements were placed on the standardization of apparatus; and procedure for getting color of petroleum wax was included.

Studies are being continued by Research Division IX with Hellige, Inc., and the National Bureau of Standards, in the development of basic specifications for glass color standards for the ASTM-Union Colorimeter. Consideration is being given to the relocation of some of the Color Numbers in the present scale so that there will be more uniform differences in the color value of the glass color standards.

Research Division X on Corrosion Tests

F. D. Tuemmler, chairman. Comments from Committee D-2 on a proposed series of copper strip corrosion standards for Method D 130, Free and Corrosive Sulfur in Petroleum Products will be reviewed and final details will be worked out to permit use of the bomb corrosion test as a substitute for the air-well test now specified in D 130.

Study of a humidity cabinet procedure is continuing. Preliminary cooperative tests using the JAN-H-792 Humidity Cabinet showed promise, but a more detailed procedure was felt necessary to insure better precision. When the revised procedure is prepared, a second series of cooperative tests will be run which will determine whether a long-range investigation of the factors influencing humidity cabinet test results is necessary.

Research Division XI on Calorimetry

A. J. Kraemer, chairman. Organized in February, 1952, this is the newest Research Division in Committee D-2. Organization plans were completed very early and the division has been active for over a year on a twofold program consisting of a study of direct methods for heats of combustion of liquid fuels by oxygen-bomb calorimeter, and a study of methods of estimating net heats of combustion of liquid fuels from physical and chemical properties—density, aniline point, carbon hydrogen ratio, etc. Both courses of investigation are continuing. In addition, a monograph on calorimetry is being considered that would set forth the essentials of good apparatus and procedure for a wide range of fuels from gasoline to petroleum coke.

Research Division XII on Graphite Tests

Gus Kaufman, chairman. This is another Research Division recently organized (1951). It consists of the main division plus sections on Nomenclature and Definitions, Chemical Analyses, Abrasion Tests, Particle Size Determination, and Sampling.

Two items reached a stage of development where they were ready for release by the division. One, nomenclature and definitions of terms relating to lubricating graphite, was referred to the Coordinating Division on Nomenclature for review before publication is recommended. The other, a proposed method of test for chemical analysis of graphite, will be published as information this year.

The program of work on abrasion testing, particle size, sieve analysis, and sampling of graphite is continuing.

Subcommittee I on Pharmaceutical Tests

C. F. W. Gebelein, chairman. Plans to publish in the ASTM BULLETIN the results of a program to develop a suitable penetrometer standard for calibrating the penetrometer used in Method D 937, Penetration of Petrolatum are under way.

A color scale for USP white and yellow grade petrolatums is under consideration.

The Subcommittee on Extreme Pressure Properties Measurement

P. A. Asseff, chairman. The program on evaluating liquid extreme pressure standards for the Timken machine is continuing. The program is being carried on to find a liquid standard or standards that can be used to calibrate the Timken machine.

Committee D-2 approved the subcommittee's recommendation for cosponsoring a paper, *Observation on Some Factors Affecting Timken Data for EP Lubrication*, by De Ardo and Kipp, at the annual meeting of the ASME in November, 1953.

A definition for "load carrying

capacity" of lubricants is being prepared and should be finished by 1954.

The Coordinating Division on Nomenclature

S. S. Kurtz, Jr., chairman. Definitions D 288, Terms Relating to Petroleum, were revised by including a definition for Stoddard solvent therein.

The division will review proposed definitions and terms related to lubricating graphite which were prepared by Research Division XII.

The Coordinating Division on Test Methods

F. D. Tuemmler, chairman. Approval was given a set of recommended practices for applying precision data given in ASTM methods of test for petroleum products and lubricants, which will be published as information in 1953. The practice will be further coordinated with the work of ASTM Committee E-11 on Quality Control, and has already been coordinated with a similar publication of the Institute of Petroleum (London).

During the year, Committee D-2 has continued and expanded its contacts with working groups of the Institute of Petroleum as part of the long-range objective of bringing ASTM and IP test methods and specifications for petroleum products and lubricants more in line. F. D. Tuemmler visited with members of the IP in England and presented some of the views of Committee D-2's working groups in this connection.

Mention should also be made of progress in bringing into closer agreement the ASTM methods of test and specifications, under the jurisdiction of Committee D-2, and the Federal specifications and methods in this field, particularly Federal Stock Specification VV-L-791, a compendium of Federal test methods for petroleum products and lubricants.

Gobus Attends International Meeting

ALEXANDER GOBUS, Director, Non-Destructive Testing Dept., North American Philips Co., Inc., attended on behalf of ASTM Committee E-7 on Non-Destructive Testing, the meetings of Commission 5 of the International Institute of Welding in Copenhagen during the week of July 6–11, 1953. Commission 5 deals with radiographic standards.

Mr. Gobus is chairman of Subcommittee II on Standard Radiographs of Committee E-7.

Colton Courier

E. E. Duque, President of the California Portland Cement Co., congratulates Wilson C. Hanna on the occasion of Mr. Hanna's fiftieth anniversary of service with the company.

Wilson C. Hanna Completes 50 Years' Service with California Portland Cement Company

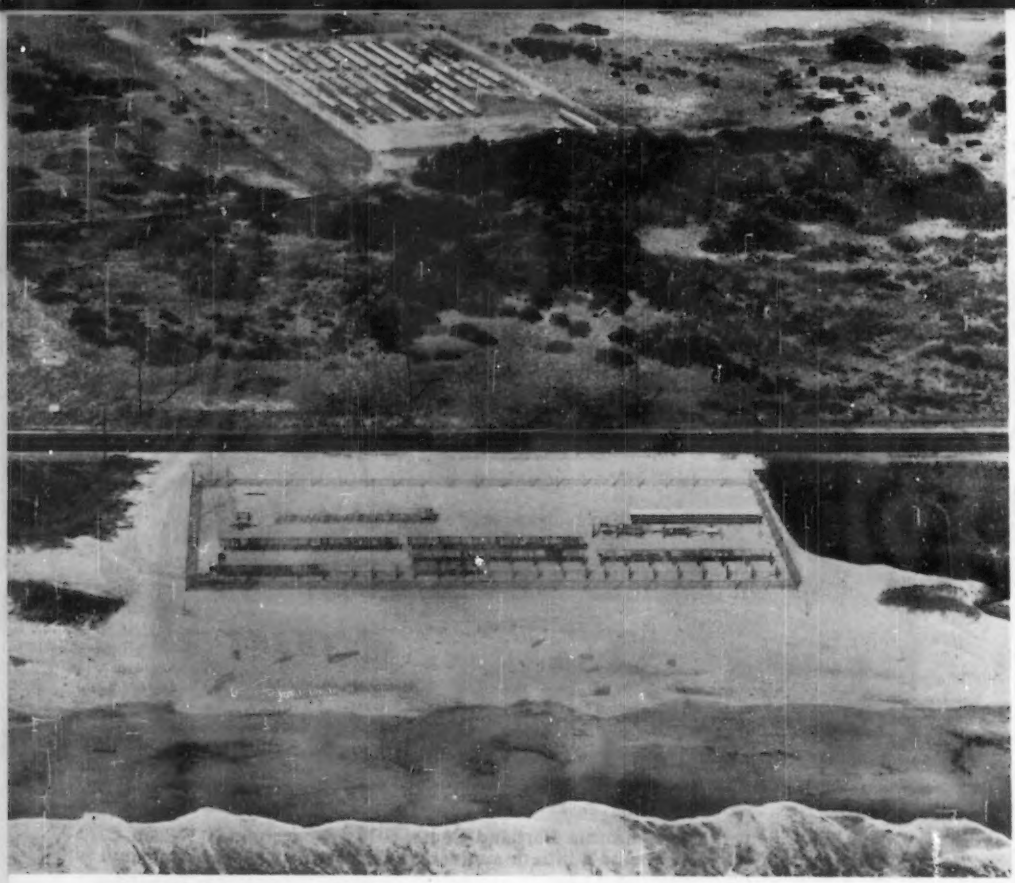
Wilson Creal Hanna, pioneer Colton (Calif.) resident and civic leader, was honored on November 4, 1953, at a dinner of 450 employees of the California Portland Cement Co. in the National Orange Show Cafeteria (San Bernardino) where tribute was paid to his long, efficient, and faithful service to the firm of which he is now Vice-President in Charge of Technical Development. The occasion celebrated the completion by Mr. Hanna of 50 years of continuous service with the company, his employment having started October 10, 1903, when he went to work in the laboratory. He is the oldest employee in point of service, and the first to complete 50 years of service with the company. The highlight of the evening was the presentation by E. E. Duque, President of the company, of a 50-year diamond service pin to Vice-President Hanna.

A resident of Colton since 1889, and long an active worker in many worthwhile local enterprises, Mr. Hanna's career in the cement business covers an era of rapid growth in the cement industry of the United States and particularly of the Southwest. Within his term of service the output of the Colton plant at Slover Mountain has increased from a few hundred barrels a day to more than 12,000 and, in addition, the new Arizona plant has increased its output to above 4000 barrels daily.

Since 1904, Mr. Hanna has been in charge of the control and testing of Colton cements, and has participated in the manufacture of cement for innumerable important construction projects throughout Southern California, Arizona, and Nevada. He also located raw material deposits and was active in the construction of the Arizona Portland Cement Co. plant, a wholly owned subsidiary at Rillito, Ariz.

In addition to his many duties with the company, he has been widely interested and active in industrial, civic, religious, fraternal and ornithological affairs. He is a recognized authority on bird-life of California and the Southwest.

Mr. Hanna has been very active in ASTM since 1905, making important contributions in both administrative, technical, and District phases of the work. A Past-Director, serving as Chairman of the Society's Membership Committee, he was elected to honorary membership in 1950. Active in many ASTM committees in the cementitious group, he is currently Vice-Chairman of Committee C-1 on Cement. He is a Past Chairman of the Southern California District.



Aerial View of 80- and 800-ft Racks at Kure Beach, N. C. These specimens are about 10 miles south of the Inco immersion tests located at Harbor Island.

Advisory Committee on Corrosion Provides Facilities for 7500 Additional Specimens

PROJECTED programs of the ASTM technical committees and a number of requests from outside interests for use of test site space have made it necessary for the Society's Advisory Committee on Corrosion to provide for additional facilities at its various test site stations. Agreement on the extent of new exposures was reached at a full-day meeting of the committee held at the International Nickel Co.'s Harbor Island test station at Wrightsville Beach, N. C., on October 2.

New Facilities

Although there is at the present time some unused test rack space at all of the sites in use, the committee agreed that 110 additional racks should be fabricated, 60 of monel (for marine exposure) and 50 of type 302 stainless steel, thus providing space for 7700 additional 4 by 6-in. specimens.

Although it had been originally planned to provide racks of one type only, the committee has since modified its earlier position and is considering fabricating other types of racks, if there are definite possibilities that they can be used by more than one committee, that is, for various programs.

There has been some slight modification of the standard 4 by 6-in specimen rack, increasing the width of the rack by about 4 in. This design will facilitate mounting and removal of specimens.

Additional pipe frames, 3 at Freeport, Tex., and 3 at Point Reyes, Calif., have recently been constructed or are currently being erected to provide support for the specimen racks. Each frame is capable of supporting ten so-called standard racks. During certain seasons of the year the Point Reyes site, which is located about one-half mile from the American Telephone and Telegraph transmitting station, is inaccessible by ordinary car or truck, the only access being by foot or by means of a four-wheel drive vehicle. The ACC has agreed to cooperate with the AT & T who maintain an adjacent test site in building a road to the site.

Committee Programs

Initiation of a number of test programs is anticipated over the next several years. Committee A-5 on Corrosion of Iron and Steel is planning a new hardware test and expects to start exposure in the Spring of 1955 at New York City, Kure Beach, N. C., and State College, Pa.

A special task group of Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys has exposed during the past year, at New York and Pittsburgh, a number of specimens designed to compare the behavior of straight chromium with chromium-nickel stainless steel.

A more extensive program of stainless steels which has been a number of years in developing is currently nearing the exposure stage and the actual exposure of the specimens is planned for the summer or fall of 1954.

Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys is planning to expose a number of specimens which have been stored and which were a part of the non-ferrous program initiated by Subcommittee VI in 1931.

Subcommittee V on Exposure and Corrosion Tests of Committee B-6 on Die-Cast Metals and Alloys put on exposure early this year at Kure Beach, New York City, and Columbus, a new series of tests on aluminum alloy SC84 with various amounts of zinc up to 2 per cent. These tests are for 1-, 3-, 6-, and 12-yr periods and the specimens are in the form of $\frac{1}{4}$-in. round tension specimens.

Committee B-7 on Light Metals and

Alloys, through its Subcommittee VIII on Atmospheric Exposure Tests, has initiated a program which includes 30 aluminum alloys and 8 magnesium alloys. Specimens have already been put on exposure at New York City, State College, Kure Beach, and Point Reyes. An additional series of specimens will be mounted at Freeport, Tex., pending completion of racks and frames. Details of this extensive test on light metals were described in a paper by L. H. Adam on *Atmospheric Exposure of Light Metals and Alloys* which was presented at the 1953 Annual Meeting of the Society.

Committee B-8 on Electrodeposited Metallic Coatings is continuing its studies on performance tests and during the past year has exposed additional specimens of copper-nickel-chromium plated specimens at Kure Beach and New York (Bell Telephone Laboratories). Also groups of 18 zinc-plated panels were exposed at Kure Beach and at the Port Authority site in New York.

Within the next several years it is probable that Committee C-19 on Structural Sandwich Constructions, through its Subcommittee II on Performance, Durability, and Simulated Service will have ready an extensive program for a wide variety of structural sandwich constructions. This work is still in the planning stage, size and shape of specimen and manner of exposure having yet to be decided.

Non-ASTM Exposure Test Programs

A number of groups outside the ASTM have expressed a desire to use ASTM test site facilities and have agreed to abide by the "Rules and Regulations Governing Test Sites by Other than ASTM Committees." Requests approved by the ACC include that of the American Welding Society for the use of pipe frame space at New York, Kure Beach, Columbus, Point Reyes, East Chicago, and Freeport. The American Welding Society program consists of more than 4000 specimens designed primarily to test the effectiveness of sprayed metal panels including coatings of aluminum and zinc in various thicknesses.

The Steel Founders Society of America has been granted permission to expose a number of cast steel specimens at the East Chicago location.

The most recent request is that received from Squier Signal Laboratory for permission to expose a number of magnesium-encased communications units at the Point Reyes test site. This request has also been approved by the ACC.

Financial Support Gratifying

It is of interest to note that the total amount pledged to the ASTM Exposure Test Site Fund has reached the sum of $105,150, more than 90 per cent of which has already been paid. The expenses during the first five years of operation have been just under $30,000, and it would appear that the estimate of $100,000 for operation of the test site facilities over a ten-year period was well founded. Many of the proposed programs will extend over a period of 15 to 20 years, necessitating repairs and maintenance of the various test site facilities as well as provision for additional facilities as other committees plan exposure programs. There is no thought of making a specific appeal for additional funds, but if there are any companies which have not previously been approached, and which would like to participate in the ASTM Exposure Test Site Program, contributions can be made by checks drawn to the order of ASTM Test Site Fund and sent to the Executive Secretary, ASTM, 1916 Race St., Philadelphia, Pa.

American Welding Society Corrosion Test Program of Sprayed Metal Coatings

ASTM has a twofold interest in the AWS Corrosion Test Program not only because of its basic interest in the protection of iron and steel but also because the AWS has been granted permission to use the ASTM test site facilities. The following report was prepared by Sam Tour, Sam Tour & Co., for presentation at the October 2 meeting of the ASTM Advisory Committee on Corrosion.

THE Corrosion Test Program of the American Welding Society Committee on Metallizing first formulated about 1950, was a modest one that would have involved only several hundred test panels. With increasing interest in the program, more and more types of panels were added and more test locations were selected. The final program includes a total of 4248 steel panels to be exposed on 128 racks to be located at 10 different test sites.

The steel panels are 4 by 6 by $\frac{1}{8}$ in. thick for atmospheric corrosion tests and 4 by 12 by $\frac{1}{8}$ in. thick for sea water corrosion tests. The Armco Steel Corp. and the U. S. Steel Co. contributed the panels.

All the panels were notched for identification, grit blasted, metallized, measured, top coats applied, and shipped to the test sites by the Metallizing Engineering Co. of Long Island City, who contributed all of the labor and materials required in this work.

1580 panels 4 by 6 in. were sprayed with aluminum and an equal number were sprayed with zinc.

1348 panels 4 by 12 in. were sprayed with aluminum and an equal number were sprayed with zinc.

Coating thicknesses of 3, 6, 9, 12, and 15 mils are being tested. For each coating thickness some panels are being tested bare, some with a single organic top coat, and some with two organic top coats. In all there are 28 types of sprayed aluminum coatings and 28 types of sprayed zinc coatings.

The atmospheric exposures will be at Kure Beach, N. C., 80-ft test site; Kure Beach 800-ft test site; Point Reyes, Calif., Freeport, Tex., New York City; Columbus, Ohio; and East Chicago, Ind. The sea water exposures will be Wrightsville Beach, N. C., mean tide, Wrightsville Beach below tide, and Gulf Coast.

The exposure periods will be for 1, 3, 6, and 12 years each. Racks will be separate for each time period so that an entire rack can be removed at one time.

To purchase some of the steel for the racks, cut, drill, and weld the racks, to purchase porcelain insulators, nuts, bolts, etc., and to defray shipping expenses, it was necessary for the committee to solicit cash contributions. Something over $2500 has been contributed; more is needed and is being solicited.

The welded steel racks themselves are being metallized and coated. This work of finishing the racks is being contributed by St. Louis Metallizing Co., St. Louis, Mo.; F. W. Gartner Co., Houston, Tex.; Chicago Metallizing Co., Chicago, Ill.; Clark Metallizing Co., Newport Beach, Calif.; Akron Sand Blast Co., Barberton, Ohio; Metalweld, Inc., Philadelphia, Pa.; and Arthur Tickle Engineering Co., Brooklyn, N. Y.

The individual panels have been distributed on a statistical analysis basis as to both test site location and time periods at the test sites. The working out of the charts for such a distribution of 4248 panels in 56 categories to 10 different test sites for 4 different time periods was a contribution from Sam Tour & Co., Inc.

A detailed set of instructions for field inspections has been prepared and is furnished to each person responsible for such field inspection. Record cards to be used to record the detailed observations in accordance with these instructions have been prepared and sent to each test site along with the panels themselves. Various members of the committee are contributing the work necessary for mounting of the panels on the racks and for mounting of the racks on the frames at each test site. The test sites at Kure Beach, New York City, Columbus, Chicago, Point Reyes, and Freeport are the ASTM test sites. The American Welding Society is thankful to the American Society for Testing Materials for their cooperation and this permission to use their test sites.

Panels have been on exposure at Kure Beach since this past winter. Within the next few months, it is hoped that racks will be delivered to all other test sites and all other panels will be mounted and on exposure. From then on, it will be a matter of waiting for the elements to do their work over the set periods of time. As each exposure period runs out, the panels will be inspected and the results will become available in the form of progress reports.

The program has been carried along as rapidly as possible to date. From now on and for the next twelve years, progress is a matter of time and the continued fine cooperation of the members of the committee.

International Plastics Meeting at Stockholm

Six draft proposals of testing methods to be recommended for use in international trade were approved at a meeting of Technical Committee 61 on Plastics, International Standardization Organization, held in Stockholm, Sweden, August 10 to 14, 1953. These methods of test pertain to the determination of water absorption, apparent densities of molding powders (pourable and nonpourable from a funnel), acetone-soluble matter of phenolic moldings, flexural strength properties, and temperature of deflection under load. These properties are quite commonly included in specifications for molding compounds and plastic materials and were among the first to be covered in the work on standardization of testing methods by ASTM Committees D-9 on Electrical Insulating Materials and D-20 on Plastics. The comparable ASTM Methods are D 570 for water absorption, D 1182 for apparent density of granular molding powders, D 954 for apparent density of nonpouring molding compounds, D 494 for acetone-soluble matter, D 790 for flexural properties, and D 648 for heat distortion temperature. In some cases some modifications of these procedures were introduced into the ISO/TC 61 Draft Proposals; these will undoubtedly be studied by the ASTM committees to determine the feasibility of having the American methods reflect the recommendations of the ISO in so far as possible in order to avoid unnecessary testing for purposes of international trade.

Progress was made on the international standardization of test methods for many other properties, of standard laboratory atmospheres and conditioning procedures for use in testing, and of nomenclature and listing of equivalent terms in various languages. Some of the other properties for which the Working Groups of ISO/TC 61 are drafting proposed international methods of test are methanol soluble matter of polystyrene; percentage of free phenol, free ammonia, chlorides, and pH of water extract of phenolic moldings; tensile properties; flammability; impact strength; and flow properties of plastics.

G. M. Kline, Chief, Division of Organic and Fibrous Materials of the National Bureau of Standards, was chairman of the meeting and Dr. H. Liander, Technical Director of ASEA, Sweden, was co-chairman. Twelve countries including the United States were represented at the Stockholm meeting. Led by Robert Burns, Bell Telephone Laboratories, the U. S. delegation included: R. Buchdahl, Plastics Div., Monsanto Chemical Co.; F. W. Busse, Polychemicals Dept., E. I. du Pont de Nemours and Co., Inc.; G. M. Kline, National Bureau of Standards; Ralph Witt, NEMA and Johns Hopkins University; and E. Y. Wolford, Chemical Div., Koppers Co., Inc., who also served as secretary.

The next meeting of ISO/TC 61 will be held either in Philadelphia, Pa., or at some location in England or on the European continent, probably in September, 1954. A decision on the time and place will be made by the American Secretariat on the basis of statements of preferences now being obtained from the member bodies of ISO/TC 61.

Third Meeting of ISO/TC 61 Plastics in Stockholm. G. M. Kline, U. S. National Bureau of Standards, chairman is fifth from left in front row.

More Unsolved Problems • • • • • •

Intriguing Questions from the Committees— What We Know and What We'd Like to Know

ABOUT three years ago the ASTM Administrative Committee on Research requested the various technical committees to submit their current research problems. These statements were reviewed by the ACR and the decision taken that such problems be published serially in the ASTM BULLETIN and reprinted for distribution to various engineering and scientific schools and to research institutions and testing laboratories as a suggested basis for possible research work.

This reprint pamphlet has been revised and expanded to include additional problems which are also being printed in the present series of BULLETINS.

The revised pamphlet, free of charge, can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

Appearing in this issue are:

Erasability of Paper
Thermodynamics of Electrodeposition
Expansion Pressures of Refractories When Heated
Mineralogic Analysis of Refractories Based on X-Ray Patterns and Differential Thermal Analysis
Formation of Paper
Siliceous Grit of Paper.

Erasability of Paper

Statement of Unsolved Problem Contributed by Committee D-6 on Paper and Paper Products

Problem:

Although several instruments have been adapted to measure this property (which is not clearly defined), and one especially designed for the purpose, there is a lack of correlation between different instruments and also a lack of correlation between the information thus obtained and practical application.

Present State of Knowledge:

A great deal has been done in developing an instrument for determining erasability based on the work of Codwise and La Fontaine which utilizes the rubbing action of a "standard" silicon carbide cloth under "standardized conditions" in a mechanical abrading instrument. The instrument as originally developed has undergone various modifications in an effort to ensure the "standard" conditions. The number of instruments available for round-robin testing is exceedingly limited and to date such round-robin tests have not shown any great reproducibility between different instruments.

Questions That Need to Be Answered:

1. The present instrument covers only the erasure of standardized writing ink markings although the principle should be applicable to all types of erasure work. Therefore the application of the test to other types of marking (for example, standardized typewritten characters) should be investigated and correlation with the standard writing ink markings studied.
2. The optimum "standard" conditions for marking, abrading surface, pressures, rubbing and the like, and whether these standard conditions can be maintained, should be determined.
3. A satisfactory definition for "erasability" should be developed together with proper interpretation of results.
4. There should be means of expressing not only the requirements necessary for the best retention of surface features after the removal of errors under standard conditions but also means of expressing the quality of the reinsertion of the same type of material with the least change in the appearance of either paper or copy.

Introductory References:

(1) TAPPI Suggested Method T 478 sm-52, "Ink Erasing Quality of Paper."

(2) TAPPI Tentative Standard Method T 476 m-51, "Abrasion Loss of Paper and Paperboard."

(3) P. W. Codwise, "Determination of the Erasing Qualities of Paper," *Paper Trade Journal*, Vol. 120, No. 8, Feb. 22, 1945, p. 136; Technical Association Papers No. 28, p. 69 (1945).

Additional information may be obtained from W. R. Willets, Chairman of Committee D-6, Titanium Pigment Corp., 99 Hudson St., New York 13, N. Y.

Thermodynamics of Electrodeposition

Statement of Unsolved Problem Contributed by Committee B-8 on Electrodeposited Metallic Coatings

Problem.

Progress in the field of electrodeposition in the direction of increasing limiting current densities and developing processes for deposition of alloys has been hampered or perhaps even halted by the lack of fundamental thermodynamic data for the concentrated solutions of electrolytes commonly employed in the metallic protective coatings industry.

Present State of Knowledge:

Although such data are available for dilute solutions of many of the salts employed in electrodeposition they are not available for solutions at concentrations used in practice. In the case of nickel deposition the mean activity coefficients of solutions of nickel sulfate and nickel chloride have actually been measured but no data at all are available for the formate, borate, acetate, fluoborate, sulfamate, or phosphate. Diffusion coefficients have been measured for the chloride and sulfate in terms of stoichiometric concentrations, but when it is attempted to apply these to calculate limiting current densities the results do not show agreement with experiment and the disagreement is not resolved by expressing solution composition in activities. The situation is even worse in regard to electrolytes used in plating copper, zinc, iron, lead, tin, and chromium. Concerning solutions used in deposition of alloys physicochemical data are almost nonexistent.

Questions That Need to Be Answered:

Recent developments in the thermodynamics of irreversible processes give promise of important headway in the theory of electrochemical reactions but in the meantime fundamental data are needed on the properties of concentrated solutions. Properties to be measured include activities, specific conductances, transport numbers, diffusion coefficients, dissociation constants, and hydrolysis constants. As a start, to provide data of immediate usefulness, the above properties should be determined for nickel sulfate, nickel chloride, copper sulfate, copper cyanide, zinc sulfate, zinc cyanide cadmium cyanide, stannous sulfate, and sodium stannate in simple aqueous solution and in common plating compositions. All coefficients and constants should refer to the activities of the electrolytes instead of the stoichiometric concentrations.

Introductory References:

(1) W. Blum and G. B. Hogaboom, "Principles of Electroplating and Electroforming," McGraw-Hill Book Co., New York, Third Edition (1949).

(2) W. A. Wesley, W. W. Sellers, and E. J. Roehl, "Electrodeposition of Nickel at High Current Density," *Proceedings*, Am. Electroplaters' Soc., Vol. 36, pp. 79–92 (1949).

(3) C. L. Faust, "Alloy Plating," *Transactions*, Electrochemical Soc., Vol. 80, pp. 301–324 (1941).

Additional information may be obtained from W. A. Wesley, Research Laboratory, The International Nickel Co., Inc., Bayonne, N. J.

Expansion Pressures of Refractories When Heated

Statement of Unsolved Problem Contributed by Committee C-8 on Refractories

Problem:

Many types of refractories expand at high temperatures. This may be due to conversion from one to another allotropic crystalline form (for example, quartz to cristobalite in silica brick), to chemical reaction (for example cristobalite + corundum → mullite in high alumina brick), to progressive solid solution (for example MgO absorption by chromite in chrome-magnesite brick), or to gas evolution as in ladle brick.

Expansion is observed in such tests as ASTM Standard Method of Test for Reheat Change of Refractory Brick (C 113 – 52)(1), but it is frequently impossible to predict whether the expansion would be harmful or beneficial in service. This would be clarified if a test were available allowing measurement of the force exerted by the expansion.

Present State of Knowledge:

Expansion due to gas evolution as in ladle brick may serve beneficially to retain tight joints in the furnace structure. Such refractories are pyroplastic at the temperature at which expansion occurs. If unloaded, they might expand 15 per cent in length at 2350 F, but in the ladle there are such restraints due to loading that there is no over-all expansion of the wall.

Expansion due to inversion, and due to chemical reactions is probably not retarded by furnace wall pressure, unless it occurs at temperatures at which the refractory may yield internally due to the presence of a liquid phase.

The expansion in high alumina compositions due presumably to mullite formation may cause up to 6 per cent linear expansion between 2550 and 2900 F. Since these are highly refractory compositions, there is uncertainty as to whether there is enough internal yielding to render the expansion harmless when the refractories are used in a confined space, such as that formed by a steel shell. The problem has been approached experimentally in test furnaces by standing the brick on end and loading them at 1 to 10 psi, as might occur in service. In some instances such loads have prevented the expansion in length when heated, but there has been an increase along the unconfined axis, represented by width and thickness.

Questions That Need to Be Answered:

The question remains as to what would occur, and what pressure would have been exerted had the brick been confined on all faces but one, as is most common in service.

Basically, the problem is one of measuring, for a given refractory whose mineralogy may be unknown, the force exerted by the expansion, so that it can be predicted whether or not it will cause trouble in refractory construction.

Introductory References:

(1) 1952 Book of ASTM Standards, Part 3, p. 639.

(2) J. O. Everhart, "Secondary Expansion in Refractory Clays," *Journal*, Am. Ceramic Soc., Vol. 20, p. 353 (1937).

(3) J. L. Hall, "Secondary Expansion of High Alumina Refractories," *Journal*, Am. Ceramic Soc., Vol. 24, p. 349 (1941).

(4) L. J. Trostel, "Absorption of Magnesia by Chrome Spinel," *Journal*, Am. Ceramic Soc., Vol. 22, p. 46 (1939).

Additional information may be obtained from R. E. Birch, Chairman of Subcommittee II on Research of Committee C-8, Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh 22, Pa.

Mineralogic Analysis of Refractories Based on X-Ray Patterns and Differential Thermal Analysis

Statement of Unsolved Problem Contributed by Committee C-8 on Refractories

Problem:

Several decades ago, it was common to run a "rational analysis" to determine the mineralogical composition of natural clays by a combination of chemical solution tests and calculations based on a series of assumptions with regard to their chemical analyses. The shortcomings of the method became clear when it was first recognized that the alkalies were not largely present as feldspar, as supposed, but as an essential part of the clay minerals.

The possibility exists that rational analysis or a complete mineral balance on a scientific basis is now a possibility. The tools would include the diffraction X-ray and differential thermal analysis.

Present State of Knowledge:

A considerable mass of published literature has accumulated on means of using the above tools for the quantitative estimate of clay minerals.

Common constituents of clays include the clay minerals kaolinite and illite, quartz, mica, diaspore, iron compounds including pyrite and siderite, calcite, rutile, and organic material.

Questions That Need to Be Answered:

As stated by Grimshaw and Roberts, "The primary requirement is to separate pure species of all minerals present, to analyze them and to find some chemical or physical test by which each mineral can be estimated in the original clay." The separation of individual constituents may involve dispersion, sedimentation, centrifuging, or other means.

Introductory References:

(1) R. W. Grimshaw and A. L. Roberts, "The Constitution of Refractory Clays; Part III—The Determination of Mineral Constitution," *Transactions*, British Ceramic Soc., Vol. 51, p. 327, June, 1952 (for modern approach).

(2) Alfred B. Searle, "The Chemistry and Physics of Clays," p. 408, Van Nostrand Co. (1924) (for older method and its inadequacies).

Additional information may be obtained from R. E. Birch, Chairman of Subcommittee II on Research of Committee C-8, Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh 22, Pa.

Formation of Paper

Statement of Unsolved Problem Submitted by Committee D-6 on Paper and Paper Products

Problem:

The property of paper referred to as "formation" has been defined as the degree of uniformity with which the fibers and other solid components of the paper are distributed. It is usually judged by the visual appearance of the sheet when viewed by transmitted light. The type and degree of uniformity is a major factor not only in appearance but in determining the impregnation or absorption characteristics for resin, varnish, wax, oil, or ink. To date there has been no simple, inexpensive instrument available for designating formation numerically for all types of paper; in general formation is described qualitatively as "wild" or "close," with qualifying adjectives. There is definite need for an inexpensive instrument which would permit numerical designation of different types and degrees of formation.

Present State of Knowledge:

There are several instruments already available for measuring formation, such as the Davis-Roehr-Mahlstrom Photoelectric Formation Tester. However none of these has met the requirements for a universal instrument suitable for both manufacturers and consumers, although formation is always a property which is a consideration even though its description is usually qualitative and empirical and a matter of personal judgment and comparison with standards.

Questions That Need to Be Answered:

1. There are different types and degrees of formation and these should first be clearly defined.
2. The type and degree of formation should be numerical expressions. A suitable instrument should be developed which will furnish inexpensive and simple means for determining and expressing formation.
3. Such an instrument should be adaptable for all types of paper.
4. The formation, properly measured and expressed numerically as to degree and type, should be correlated with printing, impregnation, and other uses to which the paper is put.

Introductory References:

(1) "Paper and Paperboard: Characteristics, Nomenclature, and Significance of Tests," Am. Soc. Testing Mats., Oct., 1951, pp. 74–75. (Issued as separate publication, *STP No. 60-A*.)

Additional information may be obtained from W. R. Willets, Chairman of Committee D-6, Titanium Pigment Corp., 99 Hudson St., New York 13, N. Y.

Siliceous Grit of Paper

Statement of Unsolved Problem Contributed by Committee D-6 on Paper and Paper Products

Problem:

The presence of abrasive particles in paper is a source of trouble because of undue wear on cutting and slitting equipment, wear and abrasion of printing plates and rolls, and defects in such functional papers as perforating grades of tapes.

Present State of Knowledge:

A method for the determination of siliceous grit was proposed about six years ago, and has found some application although correlations between the results obtained and the actual abrasive properties of some papers have been very erratic.

Questions That Need to Be Answered:

1. The present procedure does not provide for the complete separation of certain mineral fillers which do not cause abrasion so that papers containing such fillers show erroneously high "siliceous grit" values although free of abrasive tendencies. Therefore the method should be improved so as to effect complete separation of the common loading materials while retaining the abrasive siliceous grit, for example, particles intact.
2. Correlation between the siliceous grit content of paper and actual abrasiveness of the paper in end use should be obtained.

Introductory References:

(1) "Proposed Method of Test for the Siliceous Grit Content of Paper and Paper Products," ASTM BULLETIN No. 144, January, 1947, p. 48.

Additional information may be obtained from W. R. Willets, Chairman of Committee D-6, Titanium Pigment Corp., 99 Hudson St., New York 13, N. Y.

The Special Libraries Association Translations Pool

A NEW translations service is announced by the Special Libraries Association, in cooperation with the John Crerar Library, Chicago. It has been created in recognition of the increasing need for information regarding existing translations and for the availability of inexpensive copies.

The Association has deposited in the Crerar Library, 1300 translations which form the nucleus of the Pool. In the near future a list of these translations will be available for distribution. Arrangements are under way for the listing of future contributions in technological journals in the fields covered by the translations. (The ASTM BULLETIN is cooperating in this project.) Because the usefulness of the Pool will be in direct proportion to the number of translations available, contributions are solicited from government agencies, technical societies, universities, industries, and individuals. Contributions may be made by the deposit of good copies of complete translations. If copies are not available for deposit, they may be lent to the Crerar Library for a short time, with permission to microfilm, or alternatively, a 35-mm microfilm may be deposited. Permission to lend or to reproduce in photocopy is a condition of deposit.

Contributions and requests for information regarding the availability of translations should be addressed as follows:

S. L. A. Translations Pool,
John Crerar Library,
86 East Randolph Street,
Chicago 1, Illinois.

Photoprint or microfilm copies of the translations listed may be obtained at the regular rates charged by the Crerar Library. Currently, these rates are $1.40 for ten pages, or fraction thereof of photoprint of fifty pages, or fraction thereof of microfilm, *plus* a service charge of $1 for each translation (payable in advance). Discounts of 3.5 to 14 per cent are allowed on advance purchase of photoduplication coupons. A price list will be sent on request.

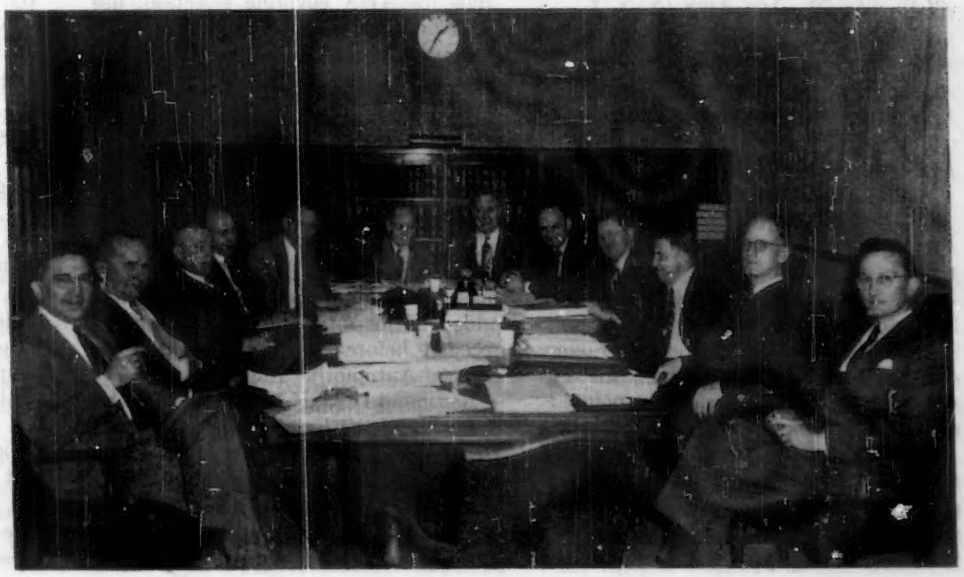
In view of the recent announcement by the National Science Foundation of the establishment of a center for holding and photoduplicating scientific translations with particular emphasis on those in Russian, the S.L.A. Translations Pool will be devoted to translations from languages other than Russian. Russian translations presently in the Pool will be transferred to the new center.

Conference on Analytical Chemistry and Applied Spectroscopy

THE Analytical Chemistry Group of the Pittsburgh Section of the American Chemical Society and the Spectroscopy Society of Pittsburgh will sponsor the Fifth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy at the William Penn Hotel March 1–5, 1954.

Features of the meeting will be a larger than usual exhibit of related laboratory equipment and a conference dinner and social hour.

ASTM committees planning to meet in conjunction with the Conference are E-2 on Emission Spectroscopy and E-13 on Absorption Spectroscopy.



Members of the American Group for ISO/TC 61 on Plastics meeting at ASTM Headquarters, are, left to right: R. E. Hess, R. K. Witt, E. Y. Wolford, R. R. Winans, C. H. Adams, H. M. Lawrence, A. H. Scott, E. F. Seaman, W. F. Bussie, R. Burns, chairman, G. M. Kline, C. R. Stock.

Random Samples . . .

FROM THE CURRENT MATERIALS NEWS

From the broad stream of current materials information flowing from "in-box" to "out-box" in a busy editorial office, random samples (mostly random) have been plucked. Thinking them worth re-showing to ASTM'ers who may have missed the original articles, we have included them here. Of course, we had to trim the samples to fit. There will be those who are not satisfied with samples, especially ones which are not really random. But these ASTM'ers can contact the institution, magazine, governmental agency, etc., who placed the original information in the stream. We have quoted literally, sometimes without quotation marks where the point of omission is obvious, and we have given credit to the source. These credit lines are also for the use of ASTM'ers whose entire curiosity has been aroused.

The Big Question

Is it necessary and economic to use austenitic steels for 1100 F steam service? Because such steels are expensive and alloying elements, particularly nickel and columbium, are in short supply, Frank A. Ritchings and Sabin Crocker have reviewed existing data and, on the strength of information in their paper recently presented before the ASME in Los Angeles, they conclude that it should be feasible to extend the use of low-alloy ferritic steels from their present top steam temperature of 1050 F at turbine throttle to a possible 1100 F at turbine throttle. But before this is done, they suggest that a *trial* installation be made in which the 1100 F steam piping consists wholly or partly of low-alloy ferritic steel. Also they think that worth further investigation is the permanence, at 1100 F, of superior physical properties which have been imparted to certain ferritic steels through favorable heat treatment. In pamphlet form, "Design of steam Piping and Valves for 1100 F," by F. A. Ritchings and Sabin Crocker, is available from ASME (Order Department), 29 W. 39th St., New York 18, N. Y.

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Quality Control to Play More Important Role

Some of today's business barometers forcast that supply has finally overrun demand. If this is true, buyers will probably be getting more "choosey."

Frank H. Steineback (Editor of *Foundry*) had this in mind several months ago when in an editorial he asked the pointed question "How's your Quality Rating?"

"The time," he wrote, "is not far away when customers will demand and get quality in any manufactured product. It may be that only those companies providing quality will be able to sell their products in sufficient quantity to provide profitable operation.

"As a matter of insurance, why not take a good look at your own operations and see if your customers are satisfied with the quality of your product?"

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Maintenance Materials

It seems that America's hotels are spending an estimated $21,000,000 each year to replace lost, worn-out, or damaged sheets, tablecloths, towels, and other linens. The American Hotel Assn. (AHA) realizing this, had its laundry and textile consultant, A. C. Bradley, prepare a manual, "Hotel Linens." The manual tells AHA hotel managers, purchasing agents, and housekeepers how to select linens with best potential wear properties, and how to control, conserve, and launder them for maximum useful life.

Because floors, carpets, paints, and cleaning or polishing compounds also have been economic headaches to hotel managements, the York Research Corp. prepared some manuals on these materials for AHA covering selection, use, and maintenance. For further information, other organizations should contact AHA, 221 W. 57th St., New York 19, N. Y.

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Variables of Shot Peening

Some wherefores of shot-blasting automotive parts to give them added life or durability were discussed recently before a committee of the Society of Automotive Engineers.

Raymond L. Mattson and W. S. Coleman, Jr., of the Engineering Mechanics Dept. of General Motors Research Labs. explained that although industries in the past few years have adopted shot peening (or blasting) and other cold working methods to increase fatigue life of the particular parts they manufacture, certain variables about these techniques to a large extent are still unexplored.

Their report centered around a series of laboratory tests in which typical automotive leaf springs were shot peened and fatigue tested. The tests, dating back several years, involved more than 100 groups of four spring specimens. These, they said, were heat treated, cold worked, and tested.

Approximately 50 of these specimens were dissected and analyzed for residual stresses.

In surveying these groups of leaf spring test specimens, the GM research team posted some general conclusions:

1. For shot peened specimens of this type it appears that there is a minimum shot velocity for each shot size to obtain best fatigue life. Air pressures greater than this value do not add to fatigue durability, hence are wasteful and costly. The minimum value is considerably lower than that normally used.

2. For shot peened specimens of this type, unless the degree of coverage (exposure time) is up to some minimum value, best fatigue life is not obtained. By using coverage greater than this value, no significant increase in fatigue life results. Hence, exposure times beyond this point are wasteful and costly.

3. For shot peened specimens of this type the influence of shot size on fatigue life is not particularly great over a full range of air pressures and exposure times.

4. For these specimens fatigue life was increased by 20 times over non-peened specimens.

5. By shot peening specimens while under tensile strain, fatigue life was increased by as much as 200 times over nonpeened specimens and 10 times over strain-free shot peening. Greatest benefits were derived from shot peening while under strains greater than 80 per cent of yield strength.

6. Shot peening specimens of this type introduces residual compressive stresses of the order of 50 per cent of the

yield strength of the material, regardless of the shot size and velocity. The depth of the compressed layer increases with both shot size and velocity, ranging between 0.006 and 0.026 for the treatments used.

7. Residual compressive stress considerably greater than 50 per cent of the yield point can be introduced by shot peening while the surface is under tensile strain.

8. Although data are limited, the magnitude of residual compressive stress appears to be reduced by fatigue testing.

9. There is a direct correlation between the magnitude of residual compressive stress near the surface and fatigue life of the specimens.

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Detergents in Radiological Decontamination

The recent explosion at Yucca Flat brought out an important point of interest to the public and to Civil Defense Officials. After that explosion, the press carried the story of the necessity for decontaminating 4 cars and a bus after the April explosion and nearly 100 cars after the May explosion. It follows that any structures at the same relative location would have been contaminated. Such surfaces must be decontaminated before they are safe for use or occupancy.

The results of a study reported by Foster D. Snell Inc. at Paris' 26th International Congress of Industrial Chemistry, in June show that the major part of the decontamination resulting from an atomic bomb explosion can be done by the housewife, if necessary, using largely materials she has on her kitchen shelf, products purchased at her corner grocery or supermarket. Some surfaces, notably plaster, require special treatment.

The nature of the fission products—new atoms produced by the explosion—depends on the time which has elapsed since the explosion and the type of bomb used. Chemically the atoms present are largely in the group from yttrium to europium, usually called rare earths.

For the investigation a group of such fission products supplied by the Oak Ridge National Laboratory was incorporated into a synthetic soil representative of the dirt formed by analysis in the air over industrial cities and containing dozens of components. This was applied to such diverse types of surfaces as tin, glass, cement, gypsum plaster, unpainted and painted wood, cotton cloth, and even the shaved skin of rabbits.

After the deposit had been allowed to dry, it was "deterged" by standard techniques using commercial soaps, light-duty syndets (synthetic detergents) and heavy-duty detergents. The degree of contamination and removal was measured with the Geiger counter, the same type of instrument used to detect deposits of uranium. It was found that heavy-duty syndets were generally more effective than either light-duty syndets or soap. That proved to be the clue to efficient removal of fission products. There is a class of chemical compounds known as sequestrants which have the property of "locking up" in the compound many elements such as calcium and magnesium and, fortunately, the rare-earth elements produced as fission products. While there are several of these sequestrants including ethylene diamine tetraacetic acid, pyrophosphates, tripolyphosphates, and even citrates, the most economical to use is Calgon, a modified form of sodium hexametaphosphate. When two parts of this harmless chemical are mixed with one part of either soap or syndet and applied in one per cent solution in water, removal of the radioactive contaminant from nearly all surfaces was nearly complete. An exception was found in the case of gypsum plaster where removal by plain water was better than with any cleaning agent. Thus radiological decontamination of any city or town after an atomic burst will present special problems requiring close technical supervision. As a typical example, water removed 47 per cent of the contamination from frosted glass, 1 per cent solution of soap removed 81 per cent but in admixture with two parts of Calgon, thus using only one third as much soap, 98.8 per cent was removed. In general, the harder and smoother the surface, the easier it is to decontaminate. With the exception of plaster, decontamination to better than 90 per cent offers no great difficulties if the appropriate materials are available.

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Faster Jet Speed—Higher Temperatures—Stronger Burner Parts

A whole new series of *sintered metal* products may result from current research and development efforts, according to Julius J. Harwood, Office of Naval Research. Success of these programs could mean decided improvement in high-temperature strength properties of relatively pure metals and considerable saving in alloying elements. Some experts believe that the best hope for getting high-temperature strength properties lies in *combinations* of *metals* and *ceramics* which are powdered, *sintered*, and formed.

The Wright Air Development Center, Dayton, Ohio, has still another program for developing better corrosion and oxidation resistance at high temperatures. Its object is to reduce amounts of nickel and other critical metals now required in jet burner parts by depositing protective (porcelain) coatings on steel (Industrial Research Newsletter, Armour Research Foundation).

In a few weeks ASTM will publish a whole symposium of information on Porcelain Enamels and Ceramic Coatings, with special emphasis on these high-temperature applications.

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Hard Coating Process for Aluminum Now Available

The new Martin Process for hard-coating of aluminum makes possible the application of this lightweight, readily available metal to many more types of equipment and parts. The hardened surface, generally 0.002 in. thick, which approximates case-hardened steel or chromium plating, has a very high resistance to abrasion and corrosion, a high dielectric strength, and a low coefficient of friction. In tests still in progress, hard-coated aluminum parts formed from the same dies used for similar steel parts, have outworn their steel equivalents 3.5 million to one million cycles and have not yet shown signs of fatigue.

Anodic, Inc., Bridgeport, Conn., is operating under the first commercial license issued by the Aluminum Company of America for the MHC (Martin Hard-Coating Process), and is devoting its entire facilities to this work. The great interest to date is among manufacturers of office machines, textile machines, gages, gears, valves, hydraulic pistons and cylinders, guide rods, plates, and materials subjected to corrosion.

In addition to great surface hardness, the MHC coating creates also a high dielectric strength, indicating potential value to electrical and electronic equipment. The coating serves as an excellent bearing surface requiring little if any, lubrication, and rapidly dissipates heat. The excellence of its corrosion resistance is indicated by its ability to withstand 5000 hr of the standard salt-spray test as compared with the 250-hr requirement for usual anodic finishes.

The MHC Process employed by Anodic, Inc., is a special anodic treatment

that creates an amorphous coat of aluminum oxide about ten times thicker and 30 to 100 per cent harder than other anodizing processes; it can be classified as "file-hard." The coating grows equally above and below the original surface, so that the normal 0.002-in. coating increases thickness 0.001 in. on the surface or 0.002 in. on the diameter, and the build-up is consistent on both the surface and undercut areas. The exact growth can be controlled within very close tolerances.

Most alloys of aluminum are suitable for the MHC Process. In general, it is best applied to those containing less than 5 per cent copper or 8 per cent silicon. The coating can be applied selectively to limited portions of the surface, or to the entire surface. Its color is determined by the alloy, ranging between amber and black. A rough surface will be made smoother, while a very smooth surface will be slightly roughened. When used to salvage parts that have been overmachined, the coating can be built up to 0.008 in. in thickness. (Information on the MHC Hard-Coating Process can be obtained from Anodic, Inc., Salt St., Bridgeport 5, Conn.)

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New Production Facilities for Titanium and Zirconium Tubing

A vacuum furnace for annealing tubing of titanium and zirconium is being installed at the Norristown, Pa., plant of Superior Tube Co. The new batch furnace can handle tubing in lengths up to 24 ft. This will help meet demand for the company's recently announced line of small titanium tubing in OD sizes from 0.125 to 1.500 in., and in wall thickness from 0.004 to 0.187 in. This new titanium tubing is particularly in demand for high-temperature and corrosion applications.

Because titanium presented many metallurgical problems not encountered with other metals, the task of mass producing small tubing from this metal on a commercial basis required 6 years of development. The titanium tubing is now produced by Superior in seamless and in welded and drawn construction.

Zirconium also presented original metallurgical problems which Superior's metallurgical staff had to overcome to achieve production of zirconium tubing. The availability of raw material of this metal for commercial usage continues to be retarded by close governmental control and consumption. Until this situation is overcome, only experimental quantities of zirconium tubing can be offered to customers.

Fatigue Properties of Music Wire and Springs

An investigation of the fatigue properties of music wire and springs, which is now under way at the National Bureau of Standards, has resulted in the development of a reversed bending analysis method for predicting the approximate fatigue strength of helical springs wound from music wire and has also yielded information about the mechanism of failure of wire springs.

Reversed bending fatigue studies were made using two types of testing machines: one designed by the Bureau, the other the Hunter wire fatigue tester. Both machines operate on the principle that a rotating curved wire must reverse its points of maximum compression and tension once each revolution. Approximately 50 specimens of four types of wire were studied under reversed bending in the Hunter machine and 100 specimens of each type in the NBS machine. When results from the two machines were correlated, no consistent difference in data was found.

Fatigue studies of short compression springs were made in another type of machine designed at the Bureau. In order to provide a comparison between the results of the reversed bending studies and the compression tests, the data obtained were used to prepare tables that give, for various life times, the ratio between the stress range in the springs and the stress amplitude in the wire. These turned out to be similar for all four types tested. The data indicate that reversed bending fatigue analysis of music wire will give the approximate fatigue strength at high stress levels of helical springs wound from that wire. However, the correlation was not sufficiently good to differentiate between samples of similar wire.

In the course of the investigation, a study was made of the mode of fracture of the springs. In a helical spring loaded in tension or compression the wire is actually twisted. Consequently, there are shear stresses in the wire which are parallel and perpendicular to its length, and the tensile stress is at an angle of 45 deg to these. Observation of the fractures showed that in almost all cases a fatigue crack had started on a longitudinal shear plane and progressed for some distance along the wire before a crack normal to the tensile stress started. Fracture of the wire occurred when the tensile crack had progressed only a short distance. These observations were verified by microscopic examination of a cross-section of the wire taken from a fracture.

Gaillard Seminar, January, 1954

Dr. John Gaillard mechanical engineer, American Standards Association staff, and lecturer at Columbia University, will hold his next seminar on industrial standardization from January 25 through 29, 1954, in the Engineering Societies Building, 29 W. 39 St., New York City.

The January, 1954, session will consist of ten conferences, one each morning, and one each afternoon, Monday through Friday. At each conference a subject on the seminar program will be presented by Dr. Gaillard and then discussed around the table.

Further details may be obtained from Dr. Gaillard, 400 W. 118 St., New York 27, N. Y., or from the American Standards Assn., 70 E. 45 St., New York 18, N. Y.

Calendar of Other Societies' Events

"Long" and "short" calendars will appear in alternate BULLETINS. The "short" calendar notes meetings in the few immediate weeks ahead—the "long" calendar for months ahead.

American Association for the Advancement of Science—Dec. 26–31, Annual Meeting, Boston, Mass.

Chemical Engineering Symposium—Dec. 28–29, Division of Industrial and Engineering Chemistry, ACS, Ann Arbor, Mich.

1954

Highway Research Board—Jan. 11–14, Annual Meeting, National Academy of Sciences Building, Washington, D. C.

Society of Automotive Engineers—Jan. 11–15, Annual Meeting, Detroit, Mich.

American Institute of Electrical Engineers—Jan. 18–22, Winter Meeting, New York, N. Y.

American Society of Heating and Ventilating Engineers—Jan. 25–27, 60th Annual Meeting, Rice Hotel, Houston, Tex.

Institute of Aeronautical Sciences—Jan. 25–29, Annual Meeting, New York, N. Y.

Society of Plastics Engineers, Inc.—Jan. 27–29, Tenth Annual Technical Conference, Royal York Hotel, Toronto, Ontario, Canada.

Society of the Plastics Industry, Inc.—Feb. 3–5, Ninth Annual Reinforced Plastics Division Conference, Chicago, Ill.

National Concrete Masonry Association—Feb. 7–10, 34th Annual Convention, Shoreham Hotel, Washington, D. C.

American Institute of Mining & Metallurgical Engineers—Feb. 15–18, Annual Meeting, New York, N. Y.

American Concrete Institute—Feb. 22–25, Annual Convention, Shirley-Savoy Hotel, Denver, Colo.

American Concrete Pipe Association—Feb. 25–27, 46th Annual Convention, Fairmont Hotel, San Francisco, Calif.

Society of Automotive Engineers—March 2–4, Passenger Car, Body and Materials Meeting, Detroit, Mich.

American Foundrymen's Society—March 8–14, Annual Convention, Cleveland, Ohio.

Steel Founders Society—March 16–17, Annual Meeting, Chicago, Ill.

American Railway Engineering Association—March, 1954, Convention, Palmer House, Chicago, Ill.

American Chemical Society—March 24—April 1, Spring Meeting, Kansas City, Mo.

Zirconium—from Rarity to Reactors

Is there a place for zirconium in industry? **Without a crystal ball we really can't say, but, in the whole field of materials, few of these have made the transit from obscurity to volume production as rapidly as has zirconium. Right now, all of its high-quantity uses are geared to the atomic age, but the properties of zirconium may win for it that place in industry.**

Originally appearing in the *Westinghouse Engineer*, this article was prepared by Charles A. Scarlott, Editor, who skillfully wove the material together from information supplied by the U. S. Bureau of Mines, the Atomic Energy Commission, National Lead's Titanium Alloy Manufacturing Division, and Westinghouse's Atomic Power Division.

Concerning a material of significance which is still new industrially, Mr. Scarlott's story discussed in a light, general way, the metal's properties and its economics, processing, and applications. We thought our members would find it just right—as a change of pace in your technical reading.

Would you read other such stories on materials, written in a similar vein for future ASTM BULLETINS? **Please write in and tell us—we would appreciate your doing so.**

ONLY five years ago all the ductile, metallic zirconium in the world could have been placed in a shoebox. It brought about $250 per lb. Mention of it in the handbooks was but the sketchiest, it being classed as one of the rare metals.

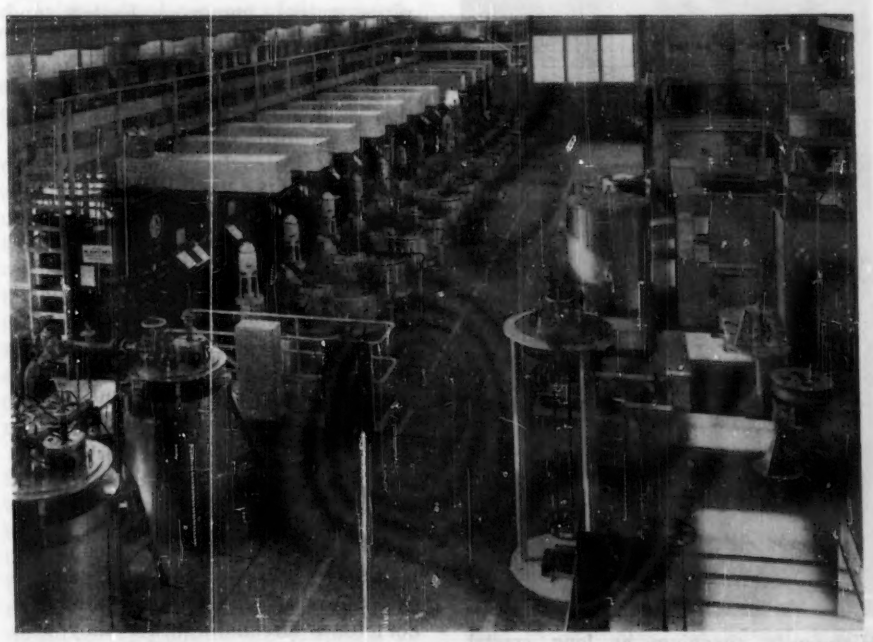
This situation has drastically changed. By the Spring of 1951, Westinghouse was producing ultra-pure crystal-bar zirconium at its Atomic Power Division in quantities measured in tons per month. And the cost had come down to less than $30 per lb. The Foote Mineral Co. was also then producing small quantities of crystal-bar zirconium. The Carborundum Metals Co., Inc., is setting up to produce for the Atomic Energy Commission sponge zirconium (from which ductile zirconium is made) at the rate of 150,000 lb per year for five years. Other firms are expected to enter the metallic-zirconium field.

Considering the production rates these facts imply, and the vast amount of work that has been done in the last three or four years in learning its properties as well as how to roll, forge, machine, and weld it, zirconium has graduated from the rare-metals class.

The skyrocket rise of zirconium from the obscurity of rare elements to a place of importance on the metallurgical scene has been a dramatic one. It is also highly significant—significant that we are entering a new age, the age of nuclear energy. Compressed into a few months was the accumulation of a mass of zirconium know-how that would normally take decades to acquire; the compelling reason was the necessity of finding satisfactory materials to clad the fissionable-fuel elements of the prototype submarine reactor and for the reactor under construction for the submarine, the *Nautilus*, being built at Groton, Conn. Zirconium is also becoming a useful material for certain jobs in industry. As yet these are all low-tonnage jobs, but this may not always be so after industry has had an opportunity to get acquainted with it and as the price declines further. Zirconium, in short, is one of a growing number of generally useful by-products of the nuclear-energy program.

Costs are coming down. Zirconium ingot of commercial purity can be had now for about $20 per lb. Remember that only 50 months ago prices were 15 times as much and almost none was to be had; this suggests the great progress that has been made cost-wise, and promises that further reductions lie ahead.

Zirconium avidly absorbs gases. It has a great capacity to capture hydrogen, nitrogen, and oxygen. It can be easily freed of hydrogen by heating in a vacuum. Oxygen can be removed by heating the zirconium in the presence of calcium. Nitrogen, however, once absorbed, is almost impossible to remove. And nitrogen



Production line for zirconium crystal bar. Crystals are grown (similar to rock candy) in tanks, as shown in right foreground.

greatly affects the metallurgical properties of zirconium, that is increases hardness and brittleness, and adversely affects its corrosion resistance. The affinity of zirconium for gases is both an advantage and a disadvantage. It greatly increases the cost and difficulty of preparing metallic zirconium; however, it is put to good use in vacuum tubes as a "getter" of those gases that are slowly released from other tube parts during operation and that would destroy the tube vacuum. Zirconium has also been used as grids in electronic tubes and as electrodes in certain lamps. Impure zirconium is hard and brittle. It has little value as a structural material. In the commercially pure form the oxygen and nitrogen have been reduced to below 0.2 per cent.

Commercially pure zirconium metal resembles stainless steel in appearance. It is ductile and malleable. It can be rolled and shaped by essentially conventional techniques. It can be readily welded in an inert atmosphere, such as helium.

Finely powdered zirconium burns, even spontaneously, with an intense white light and the emission of considerable heat. Before the days of photoflash lamps, powdered zirconium enjoyed extensive use in flash photography. It has also been used to a small extent for flares. But that does not mean that zirconium is dangerous to handle. In massive form it is fully safe. It can be readily machined as safely as stainless steel, although care must be taken with accumulations of small chips. It can be safely forged and rolled at red heat.

TABLE I.—COMPARISON OF CORROSION PROPERTIES.

	Zirconium	Titanium	Tantalum	Stainless Steel (Type 316)
Acetit acid.....	Excellent (5 to 99.5%; 60 to 100 C)	Excellent (5 to 10%; 20 C)	Excellent (all %; 20 to 392 C)	Good (5% to glacial; 35–200 C)
Ferric chloride.....	Poor (2.5 to 30%; 19 to 100 C)	Excellent (1 to 20%; 10 to 100 C)	Excellent (5 to 30%; 19 C—boiling)	Poor (1 to 5%; 21 C—boiling)
Hydrochloric acid.	*Dilute*—Excellent at all temperatures *Concentrated* at room temperature—excellent *Concentrated* at boiling—poor	Poor (5% to concentrated; 35 to 100 C)	Excellent (19% to concentrated; 19 to 100 C)	Poor (dry moist; 20 C)
Nitric acid.....	Excellent (10% concentrated; 19 to 100 C)	Good (5% to concentrated; 35 to 100 C)	Excellent (concentrated; 19 to 86 C)	Dilute to excellent Poor in concentrated at boiling

Corrosion resistance is ductile zirconium's outstanding virtue. Because of its properties certain industries are showing interest in it, particularly as a replacement for tantalum. Zirconium is more plentiful than tantalum, is lighter in weight, and even now, it is cheaper. Its mechanical wear resistance, also, is better. In many ways its corrosion resistance is superior. The metal is not attacked by ordinary atmospheres, by hot fresh water, or by salt water at ambient temperatures. It is resistant to most acids, particularly hydrochloric at room temperature, and to alkalies. See Table I. It thus may have extensive use for tank linings, pipes, valves, immersion heaters, and the like. Its indifference to hydrochloric acid at normal temperatures makes it attractive for structural parts used in the production of magnesium, pulp paper, salt, and bleaches.

Zirconium is a useful alloying agent. The strength of copper is doubled through the addition of 7 per cent zirconium. The hardened copper has good electrical conductivity (about 80 per cent of copper) and is used for such purposes as resistance-welding electrodes. It also improves the high-temperature conductivity and tensile strength of cast copper-nickel alloys. Nickel containing up to 10 per cent zirconium produces a hard alloy that requires no tempering and is useful in high-speed machine tools. In certain steels, small additions of zirconium improve hot-working properties, surface characteristics, and impact strength. Sometimes zirconium-nickel alloy is a substitute for tungsten in cutting tools. A small amount of zirconium added to magnesium alloys increases the corrosion resistance, because zirconium is a potent neutralizer for iron. Zirconium imparts high impact strength and good creep strength to pure magnesium.

Zirconium is a young material. Its ores are not in short supply. It presents no serious fabrication problems. Its cost will be reduced. While it is doubtful that it will ever be a competitor of the more common metals for large volume uses, it is certain to be extremely useful for a number of important, special purposes in many industries.

High-purity zirconium as long crystal bars, being steam cleaned after formation in deposition tank.

Pure (99.9 per cent) zirconium ingot being tested for hardness before being put into production.

Chemical Developments and Engineering Materials

By Harold L. Maxwell

The Skills of Engineering Applied to the Products of Research in a Free Society Have Produced Unparalleled Material Progress

"By the time an individual has spent 25 or 30 years in a particular line of work he should have acquired the good judgment to limit his speaking to something he knows about from first-hand experience." Dr. Maxwell, Technical Adviser, Engineering Dept., E. I. du Pont de Nemours and Co., Inc., drew upon his own experience in chemical engineering in addressing several ASTM District meetings during his term as President of the Society. A condensed version of this talk appears below.

My subject is Chemical Development and Engineering Materials. The reason for choosing this topic is a very practical one. By the time an individual has spent twenty-five or thirty years in a particular line of work, he should have acquired the good judgment to limit his speaking to something he knows about from first-hand experience.

Utilization of Materials Determines Progress

Broadly speaking, engineering materials have determined in large measure our progress as a civilized nation. A gradual transition over many thousands of years connects our modern industrial society, its ocean liners, bridges, cities, and specialized plants, with a time when none of these existed, when men living a roving life with trees the only shelter, sought out a cave in time of storm. The first step in the use of building materials was taken when an aboriginal tribesman, finding very little protection for his family, wet and shivering in a cave or the woods, selected three small trees not far apart, and bending them, tied their tops together and covered them with skins and clothing, thereby building—many years ago—man's first dwelling *above ground*. (Anyone who buys a house in a low cost housing development these days may soon conclude that building methods have not improved much since that time.) In the same way that this primitive shelter antedated architects and home decorators, so do many early chemical plants, crudely built and crudely operated, stand in pitiful contrast with what we now mean when we use the term, "a modern chemical plant."

Processes Require Containers

A manufacturing process, that is, the procedure for converting material into a more useful and valuable form, has of necessity to be carried out in some type of equipment to contain it within limits. This is true of even so simple a process as making a cup of coffee in a percolator. It is true of making neoprene or nylon; it is true also of grinding paint or even shaking up a Daiquiri. Common to all cases, the equipment in which a process is carried out determines in large measure whether the process is economically feasible and justified and, in the over-all sense, commercially profitable.

Modern chemical products are . . . a reward of the disciplined patience of the research man.

Even in these modern times some of our better known chemical reactions are carried out in simple equipment under normal conditions of temperature and pressure. Chemical products made under these simple conditions do not require elaborate equipment and are usually low in cost, plentiful, and sold on a small margin of profit. Examples of these are sodium sulfate, silicate, phosphate, and some of the pigments.

As we all know, however, the recent trend in chemical manufacture has been toward the production of new and unusual materials and products that open up new markets and outlets for the fruits of chemical research and development. Chemical manufacture once meant carrying out the simple operations of neutralization of acids and alkalies in cast iron kettles and evaporation in open pans over wood fires. Today the manufacture of chemical products, usually the results of research, utilizes modern equipment fitted to exacting engineering requirements for producing, in tonnage quantities, commercially salable products at a price that customers can afford and yet permitting operation at a profit to the stockholders.

Modern chemical products such as organic dyes, urea, synthetic rubber, nylon, "Orlon" acrylic fiber and "Dacron" polyester fiber are not born in adult maturity into a strange world. They are almost always produced first in the laboratory as a reward of the disciplined patience of the research man. Perhaps only a microscopic amount or a few grams at most of the sought-after material has been made and isolated. He examines it again and again with a strange and fascinated wonderment. He looks at this new material with a puzzled sense of incredulity that so much time and money could have gone into making so small a quantity. The next step is to produce a little more of the new material, enough to study the impurity limitations, reaction rates, corrosive effects, and thermodynamic data, and most important of all, to determine if possible, its potential as an intermediate or as a final product in meeting some commercial need. If these tests are satisfactory, the market will require larger amounts and these larger amounts must be produced promptly, at a predetermined rate, of acceptable quality and at a cost that customers can afford to pay.

Engineering Joins Research to Mass Production

At this time the engineer's doorbell rings and things begin to happen. The questions to be answered, first for the pilot plant and then for the commercial plant, are: Where and how will we build the plants? What size unit should be built? What materials shall we use for construction? Again, the drama is enacted for a laboratory curiosity of yesterday has become a new commercial product for today, requiring plant sites, building materials, engineers,

and equipment of all sizes and descriptions.

Work as a part of a cooperative team of engineers to develop equipment with which to bridge the gaps between research and commercial production, has been a most challenging experience through the years. Every new process introduces some new combinations of service conditions. In order to carry out some of the temperature-pressure operations we use thick-walled autoclaves and polymerizers lined with corrosion-resistant alloy and armored with steel, built as rugged as a blacksmith's anvil, yet operated and controlled by instruments fantastically accurate.

These instruments are truly the electronic counterparts of the sensitive fingertips of the scientist who designed them. All this must be accomplished within a conservative investment cost; building a plant that will operate with a reasonable degree of continuity, and at the same time producing a product that will maintain a reputation for quality—that one priceless asset.

If we look about we will see on all sides chemical products that are the result of basic chemical researches which have been transplanted from laboratory to commercial plant production by coordinated engineering effort. The plastic articles that appoint the interior of your automobile originated in a laboratory and have, during process of manufacture, passed through a maze of pipe lines, pumps, filters, and valves before finally emerging from heavy steel dies into the light of day as a plastic molded steering wheel or as a glove compartment door. Cotton linters and acetic acid in tonnage quantities processed in corrosion-resistant equipment finally become motion picture film, fabrics, and plastic sheeting. Wood pulp, after treatment with caustic and carbon disulfide, is well on its way to becoming cellophane but first must pass between high-alloy forgings at proper temperatures and pressures before it becomes a transparent film to serve as wrappers for candy boxes or shirts or rolled into sipper straws for the better enjoyment of your Cuba libra.

In this brief discussion it does not seem timely or appropriate to dwell on the details of corrosion testing leading to selection of engineering materials. Much of that is in the literature. It is sufficient to say that decisions on engineering materials should be based on several different factors. Corrosion rate is one; material cost and workability are others. Quality of product, that is, freedom from contamination, is still another. Others—and these are often overlooked by the inexperienced man—are the effect on maintenance cost and interruption in operations.

Maintenance Costs Can Determine Choice of Materials

Those last two, I should say, are of prime importance. Maintenance costs are usually higher than we think. In a few chemical operations the maintenance costs are equal to one half the profits from the operation. This is a startling fact. So, if you want to increase your profits by 5 per cent, all you have to do is to reduce your maintenance by 10 per cent. That can be done. We have done it many times through a proper choice of materials coupled with the utilization of proper maintenance methods.

Maintenance of chemical equipment in good operating condition is more important than it might seem. One should keep in mind that it is costly to let the time of mechanics accumulate against an order for repairing a piece of chemical equipment, let us say for instance, the retubing of a heat exchanger. Usually added to the labor cost is the value of lost production. When we separate these several items and consider also the cost of new replacement tubes, we sometimes find that the difference in over-all cost per year for using high-priced, long-life, alloy tubes is no more, and often is less, than retubing with a low-cost but short-lived tubing.

Cost vs. upkeep—the Maintenance Problem

- **tantalum costing 150 times another metal paid for itself in 11 months**
- **silver heat coils replacing lead effected definite saving**

It is good advice to calculate the over-all cost, material, and labor, on a yearly and not a first investment basis. At the same time one should know precisely the cost of a shutdown, per hour or per day. Knowing this, it is surprising to find from a comparative cost study, how much quality, even at higher first cost, we can afford to build into chemical equipment.

There are installations where cast iron at 5 cents a pound is more costly to operate than stainless steel at $1 a pound or tantalum at $50 a pound.

A case is on record where tantalum equipment at one hundred and fifty-fold increased cost replaced another metal that was barely good enough for the process. A tantalum unit doubled production and improved product quality. No process tars adhered to the tantalum tube surface and the heat transfer was even better than calculated. This permitted the use of low-pressure, low-cost steam. The tantalum equipment paid for itself in eleven months.

We once had large serpentine heating coils made from 4-in. diameter lead pipe in sulfate service. They were so heavy that a crane had to be brought in to handle each coil. When we figured the over-all cost, including steam, handling, shutdowns, and maintenance, we found it economical to replace these coils with very much smaller ones with equivalent heat transfer. The coils now in use are silver.

These examples are unusual applications. They are, however, both cases of record.

Most of us are aware that a chemical plant provides a sort of homecoming for corrosion problems from all sources. As late as World War I some chemical plants contained large quantities of wood, lead, and stoneware, some of which required frequent replacement. Stainless steel was unknown. Bronze, used in boiling tub hardware, for dilute cold acids and for some hot acids such as nitro-cotton, required replacement every two to four days. When World War II came on we had already accumulated experience on how and where to use different alloys. In boiling tubs today, a properly chosen stainless steel after ten years service, will still show machine marks on the studs. This represents an improvement of about 3000 to 1 over 1918 experience. The modern chemical plant still uses a good amount of wood for cooling towers, tanks, and the like. As for lead, the situation is changing. Although lead is low in first cost it is often expensive to maintain.

Wide Acceptance of Nonmetallics

Turning next to plastics; these nonmetallics show great promise as engineering materials for building chemical plants. Large amounts of ventilating duct work originally built of black iron or galvanized sheet have been replaced by sheet plastic which may be welded in place or assembled with stud bolts on welded flanges. Fabricated plastics have several readily evident advantages: (1) they eliminate maintenance painting, (2) they are light and easy to support, (3) their smooth surfaces reduce air flow resistance, and (4) they do not corrode and add contaminants to the air handled.

Something should be said about other nonmetallic materials used in building chemical process equipment and plants. Process vessels of steel, protected with layers of furane cements, are gaining wide acceptance for mild acid and temperature conditions. Lead-lined, homogeneously bonded, tank cars were once considered necessary for shipping

sulfuric acid, battery grade, a few years ago. Now, baking type of phenol-formaldehyde coating has proved satisfactory and more economical as well. One of the first uses of these steel transportation tanks, coated inside with a thermal setting type of finish, was for grape juice and bulk wines. Now, quite a number of chemicals are shipped in tanks coated in this way.

Another nonmetallic material that is attracting a great deal of attention is "Teflon" — tetrafluorethylene — a smooth plastic that feels like wax. It is the most inert organic material known to man and is stable at temperatures at which most plastics melt or burn. It is inert to all acids, hot or cold; for instance, it is not attacked by *aqua regia* which dissolves gold. "Teflon" is used for high-temperature electrical insulation, gaskets, and packings, is available also as an emulsion for coating, and has shown remarkable surface properties. Bakery pans treated with the "Teflon" emulsion have been used in baking for months without sticking. The coating also possesses remarkable corrosion resistance. It is, however, still very expensive; about $60 a gallon in emulsion form.

"Mylar," is one of the new films in the semiworks stage at present. A commercial plant is now in the planning stage. "Mylar" is a terpthalate derivative much like "Dacron" in many respects. It has particularly good electrical insulation properties. Although it has unusually favorable appearance and physical properties, it is quite unlikely that it will compete with cellophane which has gained such widespread acceptance in the packaging field.

Engineering the First Nylon Plant

If personal experiences find a proper place in an address such as this, particular mention should be made of the development of nylon. Nylon was announced 15 years ago, but the drama surrounding its research and engineering adaptation to the first commercial plant continues to be a stimulating influence to all of us who participated in it. It is true that there have been other spectacular new products; there is polythene, "Freon" fluorinated hydrocarbon refrigerants, "Orlon" acrylic fiber and "Dacron" polyester fiber, but for sheer thrill of accomplishment, sometimes under adverse circumstances, nylon and its development from test tube to production in millions of pounds still holds first place for many of us.

In the making of nylon it was a long way between two important events, one the extrusion of the first few inches of a nylon filament in a physician's hypodermic needle, and the other, volume production. Yet, the steps betweeen these events, although taken at a double-quick place, were nevertheless orderly and well thought out. For example, a semiworks pilot plant was authorized in January, 1938. On October 27 of the same year, nylon was announced to the world. The first commercial nylon yarn plant, built at Seaford, Del., was designed to produce 3,000,000 lb a year and was soon increased to 4,000,000 lb a year. Before it turned a wheel, before a pound of yarn was made, funds were appropriated to double the plant size to produce 8,000,000 lb of nylon yarn a year. Now 8,000,000 lb is a lot of anything, but 8,000,000 lb a year of nylon is enough to protect a lot of ankles, large and small. Actually, the truck farm, site of the first plant, produced cantalopes and cucumbers one year and tons of nylon the next. The large plant at Seaford, Del., has since been duplicated at Martinsville, Va., and again at Chattanooga, Tenn.

The truck farm, site of the first plant, produced cantaloupes and cucumbers one year and tons of nylon the next.

Like nylon, the younger members of the textile fibers family, "Orlon" and "Dacron," have appeared upon the scene. All of these fibers, together with molded plastics and polythene have within recent years burst out of the research laboratory onto the modern commercial stage, each to become as successful economically as it had been alluring and challenging technically throughout the research and development period.

Application of Materials Standards

We have discussed a number of cases where engineering materials have been the deciding factor in the successful transition of chemical processes from laboratory to plant scale of production. Many of the chemical operations we have today, and those in planning for the future, are made possible only because alloy developments and quality standardization of materials have advanced at a rapid rate. It is becoming generally recognized that successful chemical operations are paced by developments in the engineering materials field and the availability of materials of construction of high and uniform quality.

This brings us now to an all-important subject—that of materials standards. We in du Pont give a great deal of thought to the development and use of standard specifications because they are the accumulated best experience and opinion of informed men. We have a full-time staff of 16 trained people, most of them engineers, working on engineering standards and also a company-wide Engineering Standards Committee of 21 men, one from each of the ten industrial departments and others from the Engineering, Purchasing, Safety, and Fire Prevention Departments that meets quarterly. In addition to these, we have 160 engineers on 32 Standards Subcommittees that cover the needs of the du Pont Co. in its entirety. The needs for certain new standards are discussed in the Standards Committee's quarterly meeting. The standards may be initiated from any of several sources. All standards, whatever their origin, are referred by the subcomittees to appropriate authorities and consultants in the various fields of engineering. Then the proposed standards, modified as may be indicated from circulation by the subcommittee, are adopted, only after approval by the Standards Committee representing all departments concerned. The ASTM material quality standards and test methods constitute the nucleus of our standards activity. Each year we purchase millions of dollars worth of materials to ASTM specifications. The reason we do it is a very practical one—we get uniform quality of the grade required and better value for the money spent. For example, it has been reliably estimated that every dollar we spend on standards work results in a net saving of four dollars. We know of no other activity that shows this degree of certain return on the investment.

The American Indians had these same resources for a long time without building a single blast furnace, railroad, or public school, or even a crude wheelbarrow. . . ."

The social as well as the economic impact of broad new chemical developments such as these we have discussed can scarcely be calculated. We are confident that chemical research and development have resulted in thousands of new jobs, improved standards of living, and some new luxuries. Silk, in early time a luxury fabric, was within the reach of only the wealthy few. Today, thanks to the development of such synthetic textile fibers as nylon, "Orlon," and "Dacron," millions of young women on a limited budget actually dress better than did Cleopatra or the Queen of Sheba. In this connection, I might add that certain of the new synthetic fibers are so versatile that the extent of their possible uses can only be guessed today.

The Test of an Engineering Proposal

Now as we review some of these experiences that unfolded—sometimes in a surprising and spectacular fashion—the question might well be raised, "What

serves as a dependable guide in deciding which one of two or more alternate plans of action can best be adopted?" Let me say, parenthetically, that *deferred action* is rarely, if ever, one of the acceptable alternates. Sometimes a complicated equipment situation, particularly if it has to do with selling ideas to others, may be clarified by applying three questions to test our engineering proposal: (1) Is it simple? (2) Is it sound? (3) Is it modern? And by those words simple, sound, and modern I mean: Is it simple in presentation? Is it sound in theory? Is it modern in approach?

It goes without saying that almost everything we do in our day-to-day work is done in cooperation, in some way, with others. We need, therefore, to time our own actions and keep them in phase by intelligent action with everyone concerned. Now we might not all agree on what is intelligent and what is action; but we should all agree from the beginning that intelligence without action is worthless and that action without intelligence is dangerous.

The Atmosphere of Freedom

The practical benefits resulting from these chemical developments have become far reaching indeed. And the practical benefits of high wages and high standards of living could not have been achieved except under a system of free enterprise where men can study and work together as they choose, invest their savings, and use their individual or combined capital to initiate small or still larger undertakings. Only in the accumulation of adequate working capital is there assurance of profitable and continuing employment.

Perhaps there are those who do not agree that the freedom of individuals has contributed so strongly to developing our high standard of living. Some critic may even say that our unprecedented high living standard is due to our vast natural resources. These resources are, of course, a help, *but* a little thought will show that they alone cannot be the full explanation. No one would deny that we are blessed with many or varied resources, or that resources are essential to progress, but the American Indians had these same resources for a long time without building a single blast furnace, railroad, or public school—or even a crude wheelbarrow for that matter.

And this leads to my saying in conclusion that the entire story of chemical progress in the United States is a story of invention and initiative; of scientific research followed by bold developments; and, equally important, of management, with faith in our American way of life, willing to provide financial backing for mature technical judgment. All this is based on the premise that any product, in order to be of maximum use in the world, must be produced in such quantity and at a cost that will add to the comforts and pleasure of living of the largest possible number of people. There are places today where one would not be welcome to say that. If we, who have survived thus far, are to keep free in the fullest sense, we must resolve anew to keep alert to our country's needs and to our people's needs. Knowing these needs, we must then strive, ceaselessly, through research to create new products to supply those needs, and through that means maintain a high level of employment and general prosperity.

Total Phosphates in Metal Cleaning Compositions

By A. M. Mankowich[1]

THE determination of total phosphates as phosphoric pentoxide (P_2O_5) in industrial cleaning compositions is at present covered by ASTM Methods of Chemical Analysis of Industrial Metal Cleaning Compositions (D 800 – 45).[2] This method is long and laborious, including four evaporations to dryness on the steam bath and two 1-hr dehydrations. It is obvious that both silicate and total phosphate determinations are not only time-consuming but subject to inaccuracies due to the many evaporations involved. It is also possible that phosphate is lost by volatilization during the HNO_3 treatment in which polyphosphates are converted into phosphates.

A method based on perchloric acid oxidation of the alcohol-insoluble portion of metal cleaning composition, for determination of total inorganic phosphates (and silicates), has been found to be more accurate and, in the writer's opinion, faster and easier to run. The procedure is as follows:

Method: Weigh 2.000 g of the sample into a 400-ml beaker. Dry for 1 hr at 105 C. Cool to room temperature. Add 200 ml of neutral, absolute ethyl alcohol, and digest on a steam bath with frequent stirring for 1 hr. Filter through a Gooch crucible, transferring with neutral, absolute ethyl alcohol. Draw air through crucible until odor of alcohol has disappeared. Finish drying the crucible and contents in 105 C oven for 15 min. Place the Gooch crucible in the original 400-ml beaker, add 150 ml of water, bring to a boil, and boil 10 min. Filter hot through a No. 4 Whatman into a 600-ml beaker, washing with hot water. Acidify with concentrated HNO_3 (1.42 specific gravity), add 15 ml of concentrated HNO_3 in excess. Digest on a low heat hot plate for 10 min. Cool to room temperature. Add 15 ml of $HClO_4$. Evaporate to fumes, and fume 15 min. Cool. Add 100 ml of water plus 5 ml of concentrated HNO_3. Heat to dissolve all soluble matter. Filter through a No. 41 Whatman into a 500-ml volumetric flask, washing with hot water until free of acid. The residue on the filter paper consists of total silicates and is treated in the usual manner if this item is desired. Filtrate is cooled and diluted to volume. Place a 50-ml aliquot in a 400-ml beaker. Add 65 ml of water, 15 g of NH_4NO_3, and 10 ml of concentrated HNO_3 in order. Heat to 60 to 70 C. Add slowly with stirring 70 ml of molybdate solution. Let stand 1 hr. Check for completeness of precipitation. Filter through a tared Gooch crucible, using 1 per cent NH_4NO_3 solution for transferring and washing free from acid. Precipitate is given a final wash with 3 ml water. Dry at 105 C for 2 hr. Cool and weigh.

Calculation:

Weight of precipitate × 18.9 = per cent P_2O_5

Preparation of Molybdate Solution:

No. X.—Dissolve 100 g cp ammon-

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[1] Paint and Chemical Laboratory, Aberdeen Proving Ground, Md.

[2] 1952 Book of ASTM Standards, Part 7, p. 647.

ium molybdate in 400 ml water plus 80 ml concentrated NH_4OH.

No. Y.—Dilute 400 ml concentrated HNO_3 with 600 ml water.

Pour No. X into No. Y slowly, with stirring, to form the precipitating solution.

NOTES.—The hazard due to use of $HClO_4$ with organic materials is eliminated by the alcohol extraction and the HNO_3 oxidation prior to addition of $HClO_4$. The procedure could be applied to ASTM Methods D 460 – 46[3] and D 820 – 46.[4]

[3] Methods of Sampling and Chemical Analysis of Soaps and Soap Products, 1952 Book of ASTM Standards, Part 7, p. 581.

[4] Methods of Chemical Analyses of Soaps Containing Synthetic Detergents, 1952 Book of ASTM Standards, Part 7, p. 605.

A Simple Reproducible Method for Determining Metal Cleaning Efficiency*

By Arnold Miller[1] and Edward A. Hedman[1]

Describes a simple test procedure for screening metal cleaners, a test which can be used for determining optimum cleaning cycles for horological components. The methods for preparing the test specimens and representative examples of the data obtained are included.

IN THE course of an investigation of factors contributing to the deterioration of fine instruments in storage, it became necessary to develop a selective test capable of evaluating the perspiration removal efficiency, free rinsing qualities, and possible corrosion-preventive characteristics of fine metal cleaners. This procedure became desirable following observation of a high incidence of perspiration-induced corrosion on disassembled mechanisms. Perspiration and residual cleaner deposits are particularly noxious since their presence is not readily observed on metal surfaces at the time of assembly, and their corrosion-accelerating features are apparent only after such extended periods of time as encountered in storage. A survey of the literature has disclosed no suitable standardized test for the evaluation of cleaner efficiencies when applied to these "invisible" contaminants.

Clock brass was selected for the test specimens, since it was observed that this material is more sensitive to common corrosion-accelerating contaminants than the ferrous or aluminum materials also utilized in the fabrication of fine instrument components. The brass surfaces of these specimens must be reproducible, uniform, and activated. In addition, a controlled corrosive atmosphere must be provided for the exposed test surfaces, and the accelerated surface breakdown must correlate with that observed after long exposure under field conditions.

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* This work was supported by the Department of the Navy, Bureau of Ordnance.

[1] Research Physical Chemist and Research Fellow, respectively, Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

PREPARATION OF TEST SURFACES

High-leaded brass blocks (1 by 1 by ½ in.) are surface ground to a fine ground finish (~16 microinches) on both 1-in.-square sides. Surface grinding contaminants are removed with a warm detergent solution and mechanical abrasion. The blocks are dipped in two methanol baths and then soaked in a hot degreasing bath of trichlorethylene (~180 F) for 10 min. After air drying, all remaining solid particle contaminants are removed by a 10-min soak in a hot alkaline cleaner (~180 F) of the following composition:

Trisodium phosphate	12.5 g
Sodium metasilicate	25.0 g
Detergent	0.75 g
Water to make 1 liter of solution	

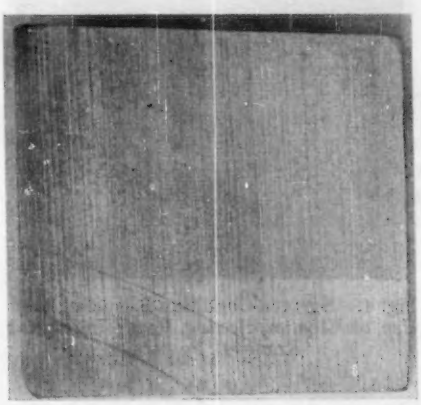

Fig. 1.—Activated and Oiled Block Prior To Test Cycle.

Surface oxide scale is removed with a mild bright dip of the following composition:

Concentrated sulfuric acid	300 ml
Concentrated nitric acid	200 ml
Water	250 ml

Two bright dipping operations 2 sec in duration each are made, followed by copious rinsing with water. The specimens are then dried with hot absolute methanol and stored under dry benzene. In all operations, specimens must be handled with monel metal tongs. The initial procedure of preparation of the test blocks as received after surface grinding is utilized only once in the lifetime of the specimen. The following procedure is used on specimens that have been cleaned and prepared as above or have previously been subjected to testing.

Each test surface is abraded to a reproducible, uniformly activated surface by using wet 400-grit silicon carbide paper. This operation is critical since a nonuniform surface will lead to invalid evaluations. The silicon carbide paper is placed abrasive side up on a glass plate and moistened with water. The block is removed from benzene, washed in methanol, and moistened with water. Polishing is carried out in a unilateral manner applying moderate pressure. The surface is inspected periodically under artificial light at a glancing angle. If any but the unilateral lines due to the polishing are noted, abrading is continued until all extraneous scratches are removed. The labor necessary in this step is considerably reduced if careful surface grinding is observed in the first step. After polishing,

the blocks are washed twice in methanol, dipped in boiling benzene, and air dried. The resultant specimens may be stored in a desiccator over magnesium perchlorate in this condition for a maximum of 48 hr. Extended storage results in passivation of the carefully prepared surface, and the surfaces must, in this case, be reactivated by polishing.

Since most clock-type mechanisms are lubricated with synthetic oils, the most suitable test contaminant was deemed to be an oil meeting specifications for AN-O-11 synthetic aircraft lubricant. In this case, carbon-treated di(2-ethylhexyl) sebacate is utilized. The test specimen is covered with a readily reproducible film by placing the block in the lubricant at room temperature for 3 min and then removing it to a glass plate in a 65 C oven so that the gross surfaces are vertical and free to drain for a period of 12 hr. The oiled surface exhibited by block 1 in Fig. 1 is ready for use in testing various cleaners and cleaning methods.

Experimental Procedure

A fingermark is impressed on one of the clean test surfaces while the other is carefully maintained in an uncontaminated condition. Duplicate specimens are prepared and both are subjected to the cleaning cycle under investigation (either machine cleaning or soak tanks). Since this investigation was concerned with components of the size and type encountered in the horological field, a standard clock-cleaning machine with heating chamber was utilized. At the end of the cleaning cycle, the test blocks are preheated for 1 hr to a temperature of 65 C, then placed in a glass humidity chamber and kept at a temperature of

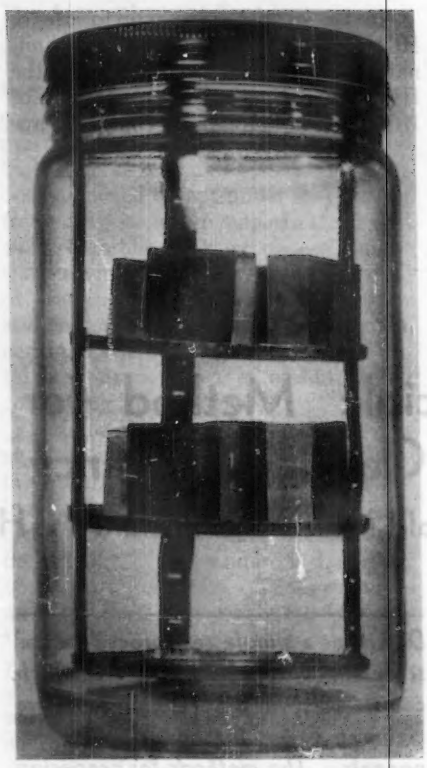

Fig. 2.—Exposure Chamber.

65 C and 100 per cent relative humidity. The complete humidity chamber is shown in Fig. 2. The preheating cycle is necessary to prevent condensation of water vapor on the cold metal surfaces immediately upon placing the blocks in the humidity chamber.

At the end of 12 hr, the blocks are removed and examined under magnification for the presence of fingermarks, etching, discolorations, pitting, and the effect of residual cleaner on the surfaces. In addition, it is important to ascertain whether these effects are localized or are gross surface phenomena.

Results

Some of the various cleaner shortcomings revealed by the test are shown in Figs. 3, 4, and 5. Surface No. 2 shown in Fig. 3 shows a mottled etching effect due to a nonfree-rinsing characteristic of a cleaner under test. The fingermarks observed on surfaces Nos. 3 and 4 in Figs. 4 and 5 have resulted from the perspiration-accelerated corrosion of the exposed metal. These two specimens reveal that the cleaners under test have poor fingerprint removal powers. A heavy film of tarnish was formed on surface No. 4, probably due to the removal of the protecting oil film during the cycle. Pitting or mild etching of a generalized nature is observed in this test, even under the most satisfactory cleaning cycles. These are normal effects observed on the sensitive brass surfaces after exposure to the corrosive atmosphere and may be considered as evidence that the cleaner has no intrinsic corrosion-preventive properties in itself. It follows then that if corrosion-preventive properties are desired in a cleaner screening program the interpretation of generalized pitting, mild etching, and light tarnishing becomes important.

As representative examples of the results obtained with this test, it was observed that kerosine emulsion cleaners and proprietory horological cleaners are poor in terms of fingerprint removal efficiency and free rinsability. Standard ammonium oleate solutions had effective cleaning powers but are ineffectual as fingerprint removers, necessitating the incorporation of methanol rinses. A detailed survey of fine instrument metal cleaners will be given in a subsequent paper.

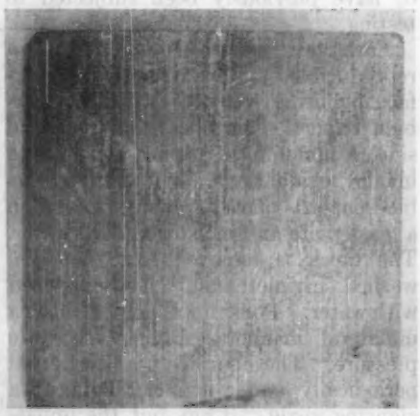

Fig. 3.—Surface Condition Induced by Presence of Residual Cleaner.

Fig. 4.—Surface Condition Resulting from Use of Cleaner Having Poor Fingerprint Removal Powers.

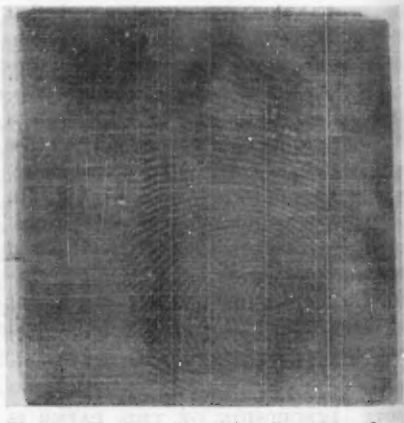

Fig. 5.—Surface Condition Resulting from Use of Cleaner Having Poor Fingerprint Removal Powers Coupled with Heavy Tarnishing.

Determination of Elastic Constants of Orthotropic Materials with Special Reference to Laminates*

By R. K. Witt, W. H. Hoppmann, II, and R. S. Buxbaum[1]

SYNOPSIS

In this paper there are given the theoretical basis and an experimental method for determining the anisotropic elastic constants of a material by measuring deflections of a thin plate of the material subject to couples on its boundary. Using the method, elastic constants are determined for three different laminates.

IN RECENT years there has been a great interest in materials that have anisotropic elastic properties. These materials include in particular glass-fabric laminates.

For technological purposes of design, for example vibration considerations, it is necessary to know the various compliance or stiffness factors of a material as presented by its elastic constants. Previous papers (**1,2,3**)[2] have presented various methods for determining these constants. In the present work some of these methods have been adapted to the purpose of determining the elastic constants from measurements of the deflections of thin plates loaded on the boundary by bending and twisting couples. Three laminates with widely different properties have been tested.

NOMENCLATURE

ϵ_x = extensional strain in x direction,
ϵ_y = extensional strain in y direction,
γ_{xy} = shear strain in $x-y$ plane,
σ_x = extensional stress in x direction,
σ_y = extensional stress in y direction,
τ_{xy} = shear stress in $x-y$ plane,
S_{ij} = elastic constants ($S_{ij} = S_{ji}$),
$E_x = \frac{1}{S_{11}}$ = Young's modulus,
$E_y = \frac{1}{S_{22}}$ = Young's modulus,
$\nu_{xy} = -E_x \cdot S_{12}$ = Poisson's ratio,
$\nu_{yx} = -E_y \cdot S_{12}$ = Poisson's ratio,
$G_{xy} = \frac{1}{S_{66}}$ = rigidity or shear modulus,
A, B, C = constants of integration,
W = deflection of plate,
h = thickness of plate,
a = width of plate (bending),
b = length of plate (bending)
c = length of side of twister,
M_B = bending couple per unitlength distributed uniformly on two opposite edges of plate,
x, y = coordinates of point on plate,
M_T = twisting couple per unit length of side of plate, and
A_x, A_{xy}, A_y = constants in differential equation of plate and are expressions in terms of the elastic constants.

THEORY

The general theory of anisotropic elasticity is developed in the technical literature (**4,5**). In this paper the material investigated is essentially orthotropic and therefore has three axes of symmetry. The test plates are rectangular in shape and cut with their edges parallel to these axes of elastic symmetry. Therefore in the usual notation (**6**) the stress-strain relations may be written for the strains in terms of the stresses and elastic constants as follows:

$$\epsilon_x = S_{11}\,\sigma_x + S_{12}\sigma_y = \frac{\sigma_x}{E_x} - \frac{\nu_{xy}}{E_x}\,\sigma_y$$

$$\epsilon_y = S_{21}\sigma_x + S_{22}\sigma_y = -\frac{\nu_{yx}}{E_y}\,\sigma_x + \frac{\sigma_y}{E_y}$$

$$\gamma_{xy} = S_{66}\,\tau_{xy} = \frac{\tau_{xy}}{G_{xy}}$$

There are then essentially four constants of elasticity: S_{ij} or G_{xy}, E_x, E_y, and

$$\frac{\nu_{xy}}{E_x} = \frac{\nu_{yx}}{E_y}$$

As may be readily shown, the displacement caused by uniformly distributed bending couples (1) M_B on two opposite sides or twisting couples M_T on all sides, is as follows. For bending, we have:

$$W = \frac{6M_B}{h^3}\,(S_{ii}x^2 + S_{ij}y^2) + Ax + By + C \quad \ldots\ldots(1)$$

$i = 1, 2$ corresponding to $j = 1, 2$ appropriate elastic constant.

For twisting, we have:

$$W = \frac{6M_T}{h^3} \cdot S_{66} \cdot xy + Ax + By + C \quad \ldots(2)$$

The equation of equilibrium for the bending of thin orthotropic plates loaded only with edge couples (**6**) is:

$$A_x \frac{\partial^4 W}{\partial x^4} + A_{xy} \frac{\partial^4 W}{\partial x^2 \partial y^2} + A_y \frac{\partial^4 W}{\partial y^4} = 0 \quad \ldots\ldots(3)$$

Since Eq 3 is of the fourth order it is readily seen that Eqs 1 and 2 which are quadratic in x and y satisfy it. Also it can easily be shown that the boundary conditions are satisfied and that Eqs 1 and 2 are really solutions for the type of loading used in this investigation. The constants A, B, and C in Eqs 1 and 2 are determined from the condition that the plates are supported at three points in the case of bending and symmetrically at two diagonally opposite points in twisting.

The determination of the elastic constants on the basis of these results is illustrated later by a numerical calculation. It is here obvious that one may measure W, M_B, h, x, and y for Eq 1 for the two principal directions of the plates and obtain two simultaneous equations for the determination of the elastic constants S_{ij}. It is also clear that one may measure W, M_T, h, x, and y for Eq 2 and readily determine S_{66} which gives the shearing modulus G_{xy}.

EXPERIMENTAL METHOD

From the theoretical formulation it is clear what measurements must be made to determine the elastic constants. For the case of bending it is sufficient to measure the deflections at the origin of coordinates and a few inches off center along the y-axis shown in Fig. 1. For the determination of the shearing modu-

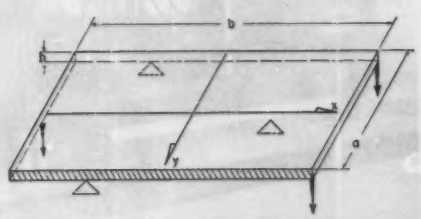

Fig. 1(*a*).—Bending Plate.

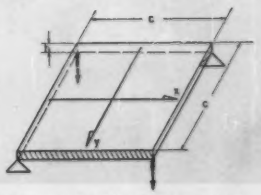

Fig. 1(*b*).—Twisting Plate.

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* Presented at the Fifth-sixth Annual Meeting of the Society, June 28-July 3, 1953.

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[2] The boldface numbers in parentheses refer to the list of references appended to this paper

lus, G_{xy}, it is clear that only a single deflection is required and this is measured at the origin of coordinates. Unlike the methods used by others, as previously mentioned, the deflections in this investigation were referred to an absolute rigid frame supported independent of the test plate as shown in Figs. 2 and 3. A rigid pipe flange of 12 in. inside diameter was machined to take a rotatable ground bar on which a sliding steel block is mounted. To this block the deflection gage or micrometer is attached. The pipe flange is supported on top of three equiheight columns of sufficient stiffness. The rotatable bar can be rotated around the center of the pipe flange and the block holding the micrometer fixed can be slid axialwise along the smooth bar. In this fashion the deflection at any point can be measured.

For nonconducting materials, it is necessary to provide an indicator to show precisely when the micrometer touches the plate; otherwise the operator might unconsciously bore the point of the micrometer into the material and cause deflections of the plate by unknown pressures from the micrometer. For this purpose a thin disk of aluminum foil about $\frac{1}{2}$ in. in diameter and about 0.001 in. thick was cemented to the surface of the plate at any location at which deflection was to be measured. A fine electric wire was soldered to this disk and connected to a pilot relay indicator which has a magnetic relay whose clicking is very helpful in quickly showing that contact has been made even under extremely small pressure. The setup is shown in Figs. 2 and 3.

For the purpose of loading the plates, a lever was usually used as shown in Fig. 2. This lever provides a known load on an auxiliary bar or plate suspended from the test plate. The auxiliary plate or bar in the bending test provides forces on two opposite ends of the test plate, and within the region between supports on the test plate essentially uniform moments are produced across the width of the plate in the vicinity of points where deflections are measured. In the case of the twisting test an auxiliary bar was suspended from two opposite corners of the test plate and loaded at its center by a lever or by small weights applied directly in the cases of small required loads.

The load was gradually increased and the corresponding deflection measured at the chosen point on the plate. The results give a load deflection curve for that particular point. For a linear relation it is the slope of this line that gives a deflection per unit load, $[P/W]$, for use with Eqs 1 and 2 in determining elastic constants.

In order to check the method and the accuracy of the test a calibration test was made with medium steel of known elastic constants. The moduli for the steel plates as determined with this test apparatus were 34×10^6 psi for Young's modulus, 12×10^6 psi for the shear modulus and 0.28 for Poisson's ratio. A measured Young's modulus in a standard tension testing machine for the same steel was 32×10^6 psi. It was considered that this constituted a reasonable check of the test procedure and method.

The materials and thicknesses of the 5.25-in. square test sections were as follows:

Glass Base Melamine Resin (GMG)	0.130 in.
Paper Base Type PBG (XX)	0.127 in.
Glass Base Silicone Resin (GSG)	0.116 in.

The over-all length of bending specimen was 10.5 in.

Two bending specimens were used for each material. One was cut so that the length of the rectangular plate was parallel to one principal direction, and the other was cut so that its length was parallel to the other principal direction. These two material-property directions are at right angles to each other in the material.

Only one twisting specimen is required. It was cut from the material so that its sides were respectively parallel to the principal axes of the material.

For the twisting tests, measurements of deflection were made for both sides of the plate. After the test on one side, the plate was turned over and measurements made on the other side. Measurements for both sides of plates in the bending tests were made only for the glass-base melamine resin. In the bending test, deflections were measured on the y-axis both above and below the x-axis. The measurements were averaged.

Results of Experiments

The force-deflection curves, from which are derived the moment-deflection relations, are plotted in Figs. 4 to 7. These represent twisting data for one plate each of the three materials and bending data for two directions each of the three materials. The slopes of these curves provide the $[P/W]$ values needed in calculating the elastic constants.

Only small percentage differences were observed in the load deflection data as taken for the two sides of the plate.

The bending deflections are for the center point of the plate and for points 2 in. above and 2 in. below the x-axis

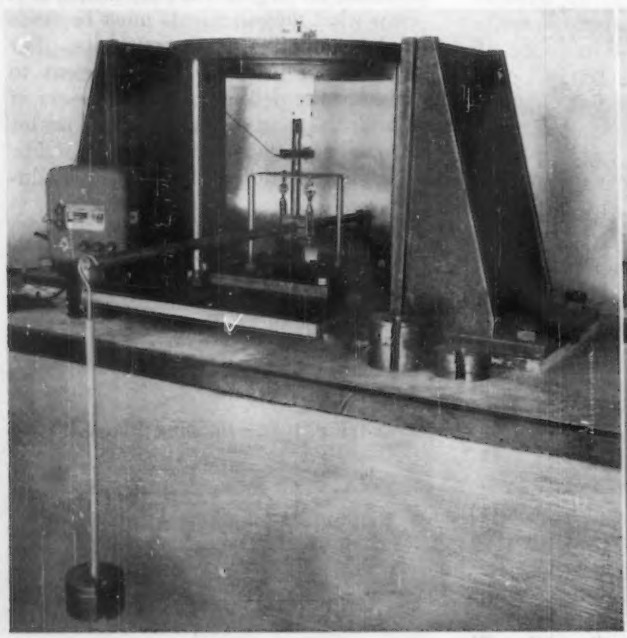

Fig. 2.—Twisting Test.

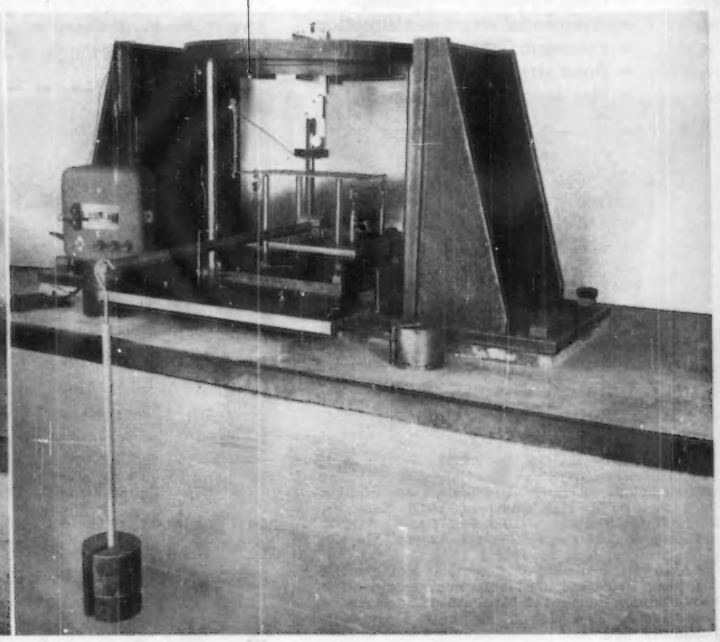

Fig. 3.—Bending Test.

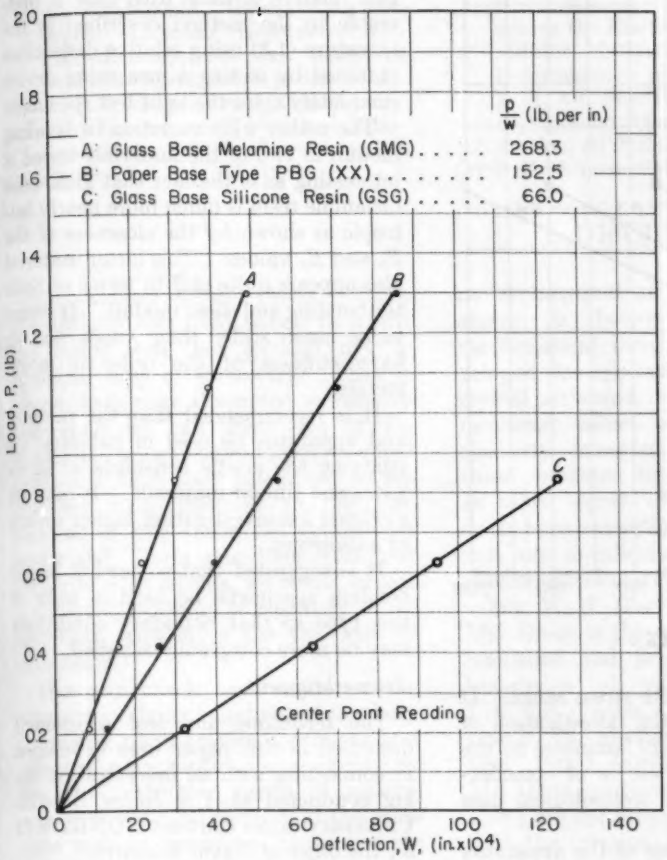
p/w (lb. per in)
A Glass Base Melamine Resin (GMG) 268.3
B Paper Base Type PBG (XX) 152.5
C Glass Base Silicone Resin (GSG) 66.0
A
B
C
Center Point Reading
Load, P, (lb)
Deflection, W, (in. x 10⁴)

Fig. 4.—Twisting Test.

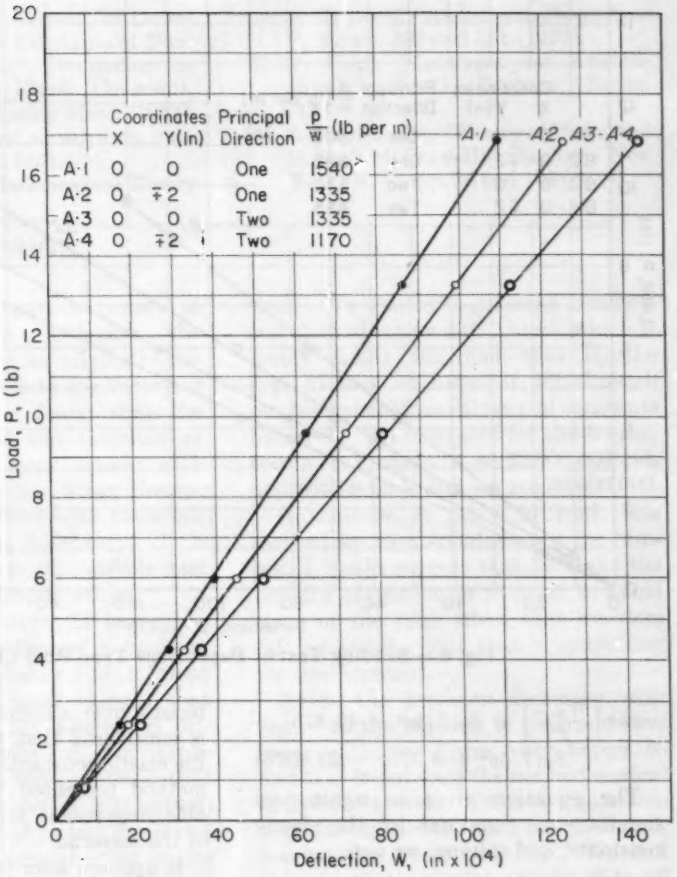

Fig. 5.—Bending Test of Glass Base Melamine Resin (GMG).

along the y-axis. Both of these measurements above and below the x-axis are not required for determination of constants, but it is considered that their average is a better result. When deflections are taken for both sides four such readings are averaged, two for each side of the plate.

Numerical Calculation

As an example, the numerical calculations are presented for the glass-base silicone resin. The shear modulus will be calculated first. As given in Eq 2 we have:

$$W = \frac{6M_T}{h^3} \cdot S_{66} \cdot xy + Ax + By + C$$

Now it is well known (6) that the twisting couples for this case can readily be written in terms of the reactions at the supports as follows:

$$M_T = \frac{P}{4}$$

so that we may write:

$$W = \frac{3}{2}\frac{P}{h^3} \cdot \frac{xy}{G_{xy}} + Ax + By + C$$

Since the supports are at the same height and $W = 0$ at supports, we can determine A, B, and C and find that

$$W = \frac{6M_T}{h^3} \cdot \frac{1}{G_{xy}} \cdot (xy + 6.25)$$

At $x = 0$, $y = 0$

$$W = + \frac{6M_T}{h^3} \cdot \frac{1}{G_{xy}} \times 6.25$$

Hence

$$G_{xy} = \frac{3 \times 6.25}{2h^3}\left[\frac{P}{W}\right]$$

From Fig. 4, curve C $[P/W]$ is 66 lb per in. The plate thickness is 0.116 in. Hence

$$G_{xy} = \frac{3 \times 6.25}{2(0.116)^3} \times 66 = 398{,}000 \text{ psi}$$

Now to calculate bending moduli and Poisson type ratios use Eq 1. We have:

$$W = \frac{6M_B}{h^3}(S_{11}x^2 + S_{12}y^2) + Ax + By + C$$

The plate is supported on three equi-height columns and the coordinates of the support points are (2.5, 0), (−2.5, 2.5), and (−2.5, −2.5).

$$M_B \cdot a = \frac{P}{2} \times 2.5 \text{ in.}$$

a = width of plate, and M = bending moment per unit width.

Then we have:

$$-ah^3\left[\frac{W_{x,y}}{P}\right] = S_{11}(7.5x^2 - 46.874) + S_{12}(7.5y^2 + 9.375x - 23.4375)$$

For principal direction No. 1, Fig. 7, at

(0, 0), $\left[\frac{P}{W}\right]$ = 720 lb per in.

(0, 2), $\left[\frac{P}{W}\right]$ = 640 lb per in.

a = 5.25 in.
h = 0.116 in.

The equation gives us two simultaneous equations for the elastic constants, and solving we get:

$$S_{11} = 26.5 \times 10^{-8}$$
$$S_{12} = -4.64 \times 10^{-8}$$

Therefore

$$E_x = \frac{1}{S_{11}} = \frac{1}{26.5} \times 10^8 = 3.77 \times 10^6 \text{ psi}$$

For principal direction No. 2, Fig. 7, at

(0,0), $\left[\frac{P}{W}\right]$ = 603 lb per in.

(0,2), $\left[\frac{P}{W}\right]$ = 548 lb per in.

a = 5.25 in.
h = 0.116 in.

The equation to be solved is

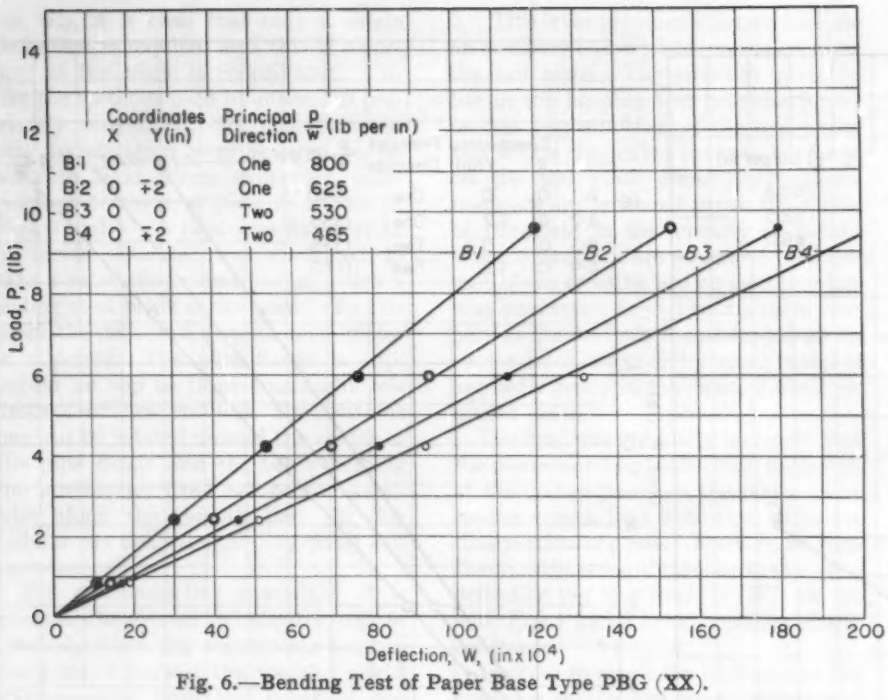

Fig. 6.—Bending Test of Paper Base Type PBG (XX).

$$-ah^3\left[\frac{W_{x,y}}{P}\right] = S_{22}(7.5x^2 - 46.875) + S_{21}(7.5y^2 + 9.375x - 23.4375)$$

The equation gives us again two simultaneous equations for the elastic constants, and solving, we get:

$$S_{22} = 31.02 \times 10^{-8}$$
$$S_{21} = -4.49 \times 10^{-8}$$

Therefore

$$E_y = \frac{1}{S_{22}} = \frac{1}{31.02} \times 10^8 = 3.21 \times 10^6 \text{ psi}$$

According to the theory $S_{21} = S_{12}$. It therefore is suggested that the two somewhat different values be averaged as follows:

$$S_{12} = S_{21} = \frac{-4.64 - 4.34}{2} \times 10^{-8} = -4.49 \times 10^{-8}$$

$$S_{12} = -4.49 \times 10^{-8} = -\frac{\nu_{xy}}{E_x}$$

and

$$S_{21} = -4.49 \times 10^{-8} = -\frac{\nu_{yx}}{E_y}$$

Hence

$$\nu_{xy} = 4.49 \times 10^{-8} \times 3.77 \times 10^6 = 0.17$$
$$\nu_{yx} = 4.49 \times 10^{-8} \times 3.21 \times 10^6 = 0.15$$

Discussion and Conclusions

The method and test apparatus described in this paper appear to be quite satisfactory for the determination of the elastic constants of orthotropic materials. However, it must be emphasized that it gives elastic constants relating strain linearly to stress only for materials actually having such a characteristic over a definite stress range. It is considered that the investigation of the elastic constants of laminates by the method presented here is of considerable importance for technological uses of the material.

It appears after use of the apparatus that the method of determining deflection relative to some fixed base is preferable to the method described in the literature (1,2) using relative deflections obtained by resting a measuring device completely upon the light test specimen.

The rather wide variation in bending moduli in two of the materials tested is interesting as is the fact that glass-base melamine resin is much more nearly isotropic as shown by the closeness of the E_x and E_y values. This latter material also appears quite stiff in terms of both the bending and shear moduli. It seems to be much stiffer than woods and to have stiffness of the order of some metals.

It is recommended that the method and apparatus be used in industry for studying the elastic constants of laminates and similar materials. It may be modified for investigating higher orders of anisotropy.

It is suggested that somewhat larger bending specimens be used in tests of this type so that boundary conditions may be more completely satisfied.

Acknowledgment:

The technique and test equipment described in this paper were developed in connection with an investigation being conducted at The Johns Hopkins University under contract NONR248.12 for the office of Naval Research.

TABLE OF ELASTIC CONSTANTS.

Material	E_x, psi	E_y, psi	G_{xy}, psi	ν_{yx}	ν_{yx}
Glass base silicone resin	3.77×10^6	3.21×10^6	0.398×10^6	0.17	0.15
Paper base type PBG (XX)	2.65	1.99	0.665	0.31	0.23
Glass base melamine resin	5.11	4.87	1.140	0.20	0.19

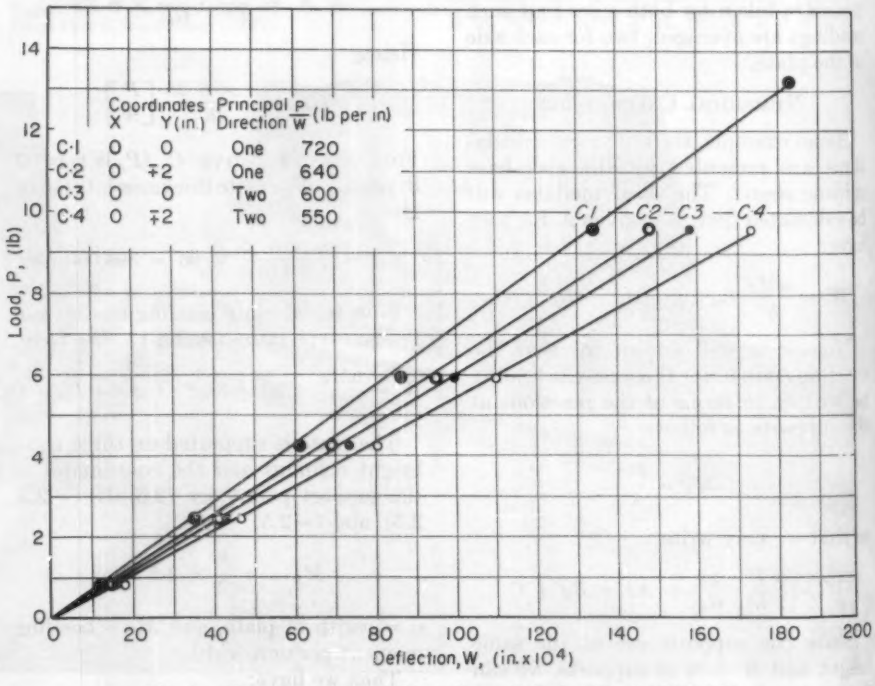
Coordinates X Y(in.) Principal Direction P/w (lb per in)
C-1 0 0 One 720
C-2 0 ∓2 One 640
C-3 0 0 Two 600
C-4 0 ∓2 Two 550
C1
C2-C3
C4
Load, P, (lb)
Deflection, W, (in x 10⁴)

Fig. 7.—Bending Test of Glass Base Silicone Resin (GSG)

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DISCUSSION

MR. ALBERT G. H. DIETZ.[1]—Have the authors also tried panels in which the edges were not parallel to the principal axes of symmetry? That is to say, have they attempted to measure the—shall we call them—E_{12} or E_{21} values at various angles to the principal axes, and have they attempted to see whether those conform to the predictions of the theory of orthotropic materials? For a glass fiber reinforced laminate such as this, we would expect a different modulus of elasticity at 45 deg than parallel to the two axes of symmetry.

Has any check been made on the measured values of modulus of elasticity by taking plain tension specimens and measuring the modulus of elasticity by the usual orthodox means of making a tension test (and possibly at the same time making transverse measurements to get Poisson's ratio)? If that has been done, do the two methods of measurement give essentially the same results? They should, of course. In theory there should be no difference in the values obtained by different methods of measurement.

I should like to know also what precision of measurement is necessary in measuring the deflection at the centers of the plate by these methods. Others who have used a similar twisting method for measurement of modulus of rigidity have reported that extreme accuracy in measurement is required because the deflections are likely to be small.

Just to corroborate the fact that these theories do hold water, some years ago we had occasion to check some work which had been done abroad on the orthotropic properties of wood. Wood is an outstanding example of material which has three axes of symmetry, the longitudinal, radial, and tangential. In this particular instance, we wanted to test the orthotropic theory for three dimensions, not just the two dimensions of a thin plate.

Using the fundamentals which are suggested in the authors' references, we made measurements of the modulus of elasticity. We had 36 blocks which were cut parallel to the longitudinal and radial axes and at quite a variety of angles in between. Although the mathematical theory as originally developed was applicable to the theory of crystal structure, we found that the measured values of the modulus of elasticity coincided very closely with those predicted by the Voigt theory. In other words, orthotropic materials do behave according to theory. It is not just a collection of symbols and mathematical exercise; it works.

MR. W. H. HOPPMANN, II (*author*).—Mr. Dietz is the author of a book on laminates and probably has a great knowledge of various things that I do not possess. My interest is primarily in mechanics of the problem. But I think the questions that Mr. Dietz has raised are of that nature.

We did not attempt to test the plates with the principal axes at other angles than parallel to the sides of the plate. We deliberately chose the sides of the plate parallel to what we thought were the principal axes of the materials. However, to work at other angles is not difficult, and this would be very interesting for someone to do. I might mention that Mr. Smith, who is a mathematician at the University of Florida now—I think he worked with Mr. March years ago—gave a paper at the June Meeting of Applied Mechanics, in Minneapolis, and he had the very interesting problem of designing laminates by actually doing what Mr. Dietz suggested. By taking materials for which we know the properties in several directions he proposes to put them deliberately together in a certain fashion. The composite may be molded together in one piece. He can then predict what the composite properties are going to be. Personally, I think this is a very intriguing idea.

The simple answer is that we did not actually do that in this test. We had limited time and our objective is an entirely different one. We are interested in different orthotropic structures, not necessarily plastics only.

With regard to the tension specimen to obtain constants, the answer again is no, unless Mr. Witt has some information with which I am not familiar.

In this particular test we did not pull tension specimens. We did—and I mention it in the paper—do this with steel. We wanted to get some idea how our method works out. Steel, which is pretty nearly isotropic—that is, the type of steel we have—if put through our tests should reveal normal constants for steel. We measured for the tension specimen a modulus of 32,000,000 psi, and with a plate test we got 34,000,000.

If someone is going to work this method up as a standard test for himself, I would suggest that he make the bending plates longer in order to avoid some of the edge effect that we were talking about. But that is something for development.

As to the precision necessary with regard to the twisting to determine the shear modulus, I was very happy to find that in our tests the method worked marvelously well. On two pins, two opposite edges of the plate are supported, leaving the other two free. We had thought that the plate might slide off into space. However, with a reasonable amount of care, it can be kept in place, and it is no trouble at all to twist. One finds fairly substantial deflections of the plate with the loads being used, and these are remeasured with just an ordinary micrometer. We estimated to ten-thousandths and with that we got the results which are certainly linear and seem to be reasonably good.

We have had no experience with the compression test. With respect to the Voigt theory referred to, I should like to refer to the list of references. I can recommend strongly to those of you who are interested to look at some of the work of Bergsträsser in Germany, Hearmon in England, Kuenzi in this country, and Voigt, referred to by Mr. Dietz, wrote a book on "Kristallphysik" about the turn of the century.

MR. R. K. WITT (*author*).—I was not prepared to give you any precise values on these particular laminates, but we did have modulus data on the laminates that we were working with. They agreed very well with the data that we got from the bend test and the twisting test data, in all three of the cases.

We were fairly sure of the precision of those particular data since the equipment that was used was the normal stress-strain recording equipment, and we had a fairly representative number of samples in determining those data.

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A Method of Making Edgewise Bend Tests of Rectangular Bus Bar

By C. O. Smith[1] and F. M. Howell[1]

In the use of rectangular electrical bus bar, particularly in the construction of switchboards and other control equipment for electrical machinery, it frequently is necessary to make 90-deg bends in the bars. Flatwise bends, which are made with the thickness of the bar radial to the bend, do not present much of a problem since bus bar generally is very ductile. Edgewise bends, which are made with the bar remaining in the plane of the width, obviously present appreciably more of a problem.

The bending qualities of bus bar are of sufficient importance that the ASTM Standard Specifications for Copper Bus Bar, Rod, and Shapes (B 187–52)[2] require that rectangular bars have certain bend characteristics, both flatwise and edgewise, although bend tests need be made only when required by the purchaser. The inclusion of similar edgewise bend requirements in ASTM Tentative Specifications for Aluminum Bars for Electrical Purposes (Bus Bars) (B 236–52 T)[3] is now under consideration by ASTM Committee B-7 on Light Metals and Alloys.

To determine the flatwise bending properties, no elaborate equipment is required, but when it was desired to investigate the edgewise bending properties of bus bar, no suitable equipment seemed available. For specification purposes, equipment for edgewise bending should provide means of bending smoothly and uniformly, around various radii, bus bar ranging in size from $\frac{1}{8}$ by $\frac{1}{2}$ in. to 1 by 4 in. Provisions must be made for maintaining the bar in its original plane and restraining it from excessive thickening or wrinkling on the inside of the bend.

It is the purpose of this paper to describe and discuss a bend testing machine developed at the Aluminum Research Laboratories which, while not meeting all of these requirements, can be used to make edgewise bend tests of bars ranging in size from $\frac{1}{8}$ by $\frac{1}{2}$ in. to $\frac{3}{16}$ by 4 in., $\frac{3}{8}$ by 3 in., and $\frac{1}{2}$ by 2 in. around radii of $\frac{1}{2}$ to 4 in. Some data for EC aluminum bus bar are included.

This type of machine can be used to determine the minimum radius around which a bar can be bent. The minimum radius so determined indicates what radius can be used in manufacturing operations when suitable equipment and procedures are used.

The machine described employs a horizontal rotating table with a restraining device to minimize wrinkling of the inner edge of the bar and to keep the bar flat. The machine is equipped to bend bar in sizes up to $\frac{1}{2}$ by 4 in. over radii of $\frac{1}{2}$, $\frac{3}{4}$, 1, 2, 3, and 4 in. The authors propose an arbitrary criterion of a satisfactory edgewise bend test and discuss the reproducibility of test results and the effect of width-to-thickness ratio on the ability of bar to be bent edgewise satisfactorily.

Description of Machine and Method

The machine is actually a modification of a machine built originally for making cold bend tests (flatwise type) of bar about various radii. While it was designed to make bends around radii of $\frac{1}{2}$, $\frac{3}{4}$, 1, 2, 3, and 4 in. in bar up to $\frac{1}{2}$ in. thick, the power available in the machine is not sufficient to make edgewise bends of 4-in. wide bar greater than $\frac{3}{16}$ in. in thickness. The machine as used in making edgewise bend tests is shown in essence in Fig. 1 while a photograph is shown in Fig. 2. A typical example of an edgewise bend is shown in Fig. 3.

A $\frac{1}{2}$-hp motor, M, with a reversing switch, S, drives a worm, W, through a gear box, G. The worm engages a gear, F, directly connected to a table, T, which is rotated at a speed of about 180 deg per min. This table has a graduated scale around its circumference to indicate the angle of rotation. A removable post, P, is in the center of this table. This post can be replaced with a smaller one for bending around a smaller radius, or rings, R, can be placed on the post for bending around larger radii. A bearing ring, K, circles this center post and rests on the table. A restraining cap, C, is recessed to fit over the center post and is held down by a large cap screw which screws into the center post.

The first step in preparing to make a test is setting up the machine for the desired radius. The bearing ring is placed in position and the restraining cap then placed over the center post. Proper spacing is set between bearing ring and restraining cap. Experience has shown that a clearance of 5 to 10 per cent of the bar thickness is suitable, with the greater clearance being more desirable for thicker bars. It was found that the easiest way to set the proper spacing was to use three spacers approximately equidistant around the center post. The restraining cap is raised or lowered by adjusting the set screws (which bear on a thin plate on top of the center post) until the spacers are just a snug fit between bearing ring and restraining cap. The cap screw is then put in place and tightened until it is just slightly more than finger tight.

The bar to be bent is placed in the opening between the bearing ring and restraining cap. A drive pin, D, is bolted into the rotating table in one of the holes provided, selecting the hole closest to the restraining cap. A steel back-up bar, B, is inserted between the roller bearings of the arm, E, and the test bar to prevent the rollers from indenting the bar edge and thereby restricting movement. The roller arm, E, is pivoted at one end, and the other end is moved toward the test bar by turning the screw, H, until the arm, back-up bar, and test bar are in contact and the test bar is in contact with the center post.

The machine is started by pushing the "forward" button (at S). The table, center post, bearing ring, restraining cap, and drive pin rotate about the center of the table as indicated in both Figs. 1 and 2. The drive pin bears against the leading end of the test bar while the other end of the test bar is restrained from rotating with the table by the stationary roller arm. The section of the test bar in contact with the back-up bar is free to move in a direction along the roller arm as shown by the arrow on the test bar in Figs. 1 and 2. The table is rotated until the desired

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[2] 1952 Book of ASTM Standards, Part 2, p. 124.

[3] 1952 Book of ASTM Standards, Part 2, p. 187.

angle of bend (usually 90 deg) has been obtained. The machine is stopped, the restraining cap removed, and the specimen taken from the machine and examined.

Other Methods

A number of other procedures and test setups using the machine were tried before the above procedure was selected. Attempts to bend the bars, especially those of the larger width-to-thickness ratios, with no vertical restraint at the inside edge of the bend were notably unsatisfactory because of severe wrinkling of the inside edge. A set of slotted guide bars on the roller arm and on the drive post to hold the bar were also unsatisfactory.

For bending the smaller sizes of bar, still another method was tried. A pack of an odd number of pieces of equal length was used in which the combined thickness equaled or just surpassed the width of the bar being tested. This pack was clamped tightly with four *C*-clamps to provide the necessary sidewise restraint, thus minimizing wrinkling of the center piece, which was considered to be the test specimen. The whole pack was then bent by direct central loading as a simple beam in a universal testing machine. This pack bending arrangement was more successful than some other methods that were tried but was definitely inferior to the method using the bend machine.

Criterion of Failure

In bend testing, a question sometimes arises as to what constitutes a satisfactory bend. In the case of flatwise bends, this must be determined by visual examination of the periphery of the bend for cracking and comparing it with the original surface. The problem is much greater in the case of an edgewise bend since there is thickening along the inner edge and thinning along the outer edge of the bend. In most cases, the thickening is reasonably uniform with an occasional case of wrinkling in thin sections. This wrinkling can usually be avoided if the clearance between the test bar and the restraining cap is decreased. The thinning along the outer edge of the bend generally is uniform. Under some conditions, however, there may be one or more points of localized thinning, and in extreme cases, this localized thinning may proceed so far that actual fracture occurs. Obviously, the latter case is unsatisfactory while uniform thinning is not objectionable. For specification purposes, an intermediate dividing line must be established.

A purely arbitrary but practical limit was selected for the amount of allowable localized thinning. If the minimum local thickness is 90 per cent (or greater) of the maximum thickness of the outer edge along the middle 60 deg of a 90-deg bend, the bend is considered to be satisfactory. The middle 60-deg portion of a 90-deg bend was selected since it has been found that while the thinning may be uniform over a somewhat greater portion of the bend, the 60-deg portion is certain to be reasonably uniform and, in addition, the angle is readily determined.

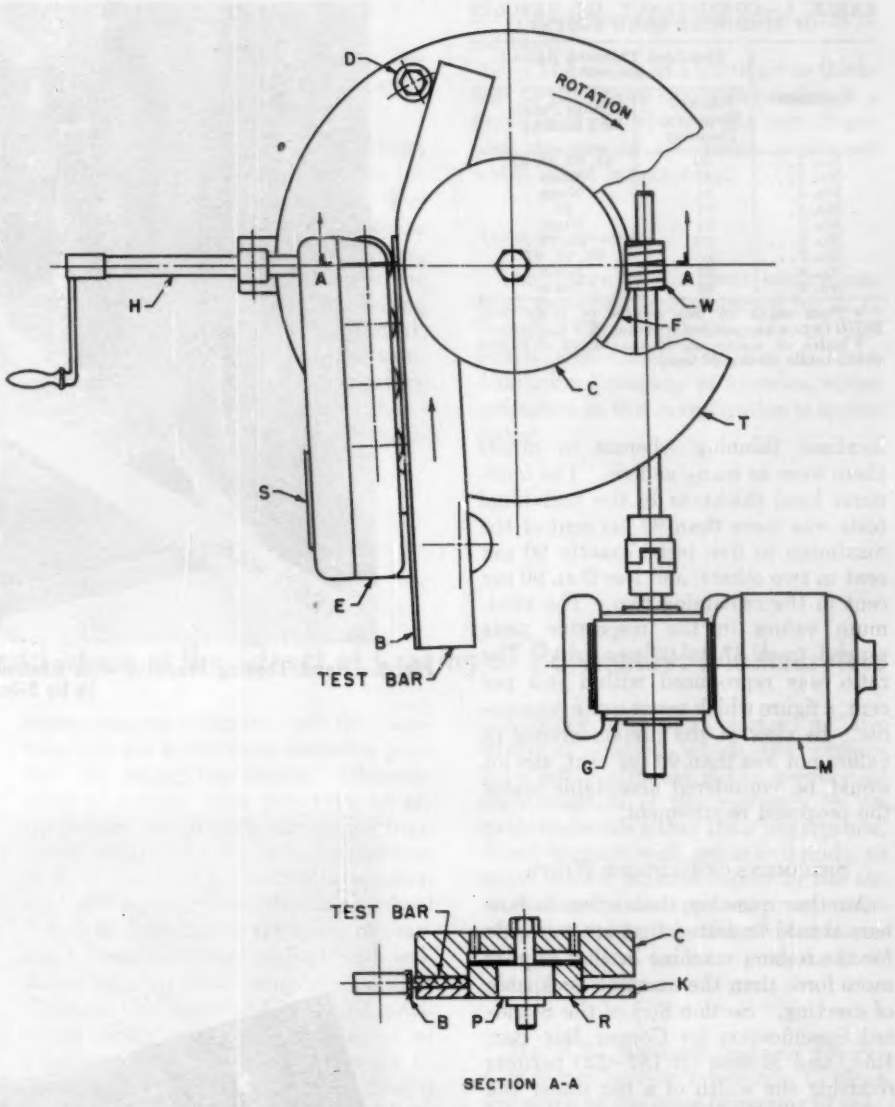

Fig. 1.—Schematic Drawing of Machine for Making Edgewise Bend Tests.

It was also found that when localized thinning occurs on the outside edge it is most likely to occur at about 15 deg from the start of the bend. Measurements of several bars after bending showed that, as an aluminum bar is bent around a radius equal to its width ($1W$), the thickness of the bar at the outside of the bend decreases about 16 per cent and at the inside of the bend increases about 20 per cent, even though the original clearance was set at only 10 per cent or less. The bolt holding down the restraining cap must, therefore, have stretched and perhaps bent slightly. It was found that the inside edge thickness increases rapidly to approximately maximum at the 15-deg location. Thus, the specimen at this stage had to withstand the force required to actually bend the specimen plus that required to strain the bolt.

In tests in which a bar shows localized thinning, the degree of reproducibility of results is important. To evaluate reproducibility, tests were made on nine specimens from a single lot of $\frac{1}{4}$-by 3 in. EC-H13 aluminum bus bar which had shown borderline localized thinning. The specimens were bent around a radius of $1W$, with results as summarized in Table I. In about half of the tests there was only one area of

TABLE I.—CONSISTENCY OF RESULTS OF EDGEWISE BEND TESTS.[a]

Specimen	Localized Thinning Ratio,[b] per cent	
	Point of Maximum Thinning	Other Points of Thinning
No. 1....	90	95, 95, 95, 97
No. 2....	87	None
No. 3....	91	None
No. 4....	91	97
No. 5....	91	None
No. 6....	90	92, 96
No. 7....	89	96, 97, 97
No. 8....	93	None
No. 9....	93	None

[a] Tests made on one sample of ¼-by 3-in. EC-H13 bus bar around a radius of 3 in.
[b] Ratio of minimum to maximum thickness over middle 60 deg of bend.

localized thinning whereas in others there were as many as five. The minimum local thickness in the individual tests was more than 90 per cent of the maximum in five tests, exactly 90 per cent in two others, and less than 90 per cent in the remaining two. The minimum values in the respective tests ranged from 87 to 93 per cent. The ratio was reproduced within ±3 per cent, a figure which seems quite reasonable. In view of the preponderance of values not less than 90 per cent, the lot would be considered acceptable under the proposed requirement.

Specimens of Reduced Width

Another question that arises is how bars should be tested that are too wide for the testing machine or that require more force than the machine is capable of exerting. Section 8(*c*) of the Standard Specification for Copper Bus Bar, Rod, and Shapes (B 187 – 52) permits reducing the width of a bar under the following limitations:

"When a bend test specimen is machined, at least one of its original surfaces shall be retained. This surface shall constitute the outer periphery of the bend which shall be made on a radius equal to that dimension of the machined specimen radial to the bend."

This indicates that reducing the width and testing the reduced width around a radius equal to the reduced width (1*W*) is an acceptable procedure. This procedure in edgewise bend tests could rather easily lead to controversy regarding the acceptance of material.

To study this factor, tests were made on two lots of rolled aluminum bus bar having larger ratios of width to thickness than are produced commercially. One was EC-H13, ⅛ by 3 in., with a W/t ratio of 24; the other was EC-H17, $\frac{3}{16}$ by 4 in., with a W/t ratio of 21.3. Neither of these could be bent edgewise full size around 1*W* without fracturing. Subsequent tests of each were made using specimens of reduced widths, as summarized in Table II. They showed

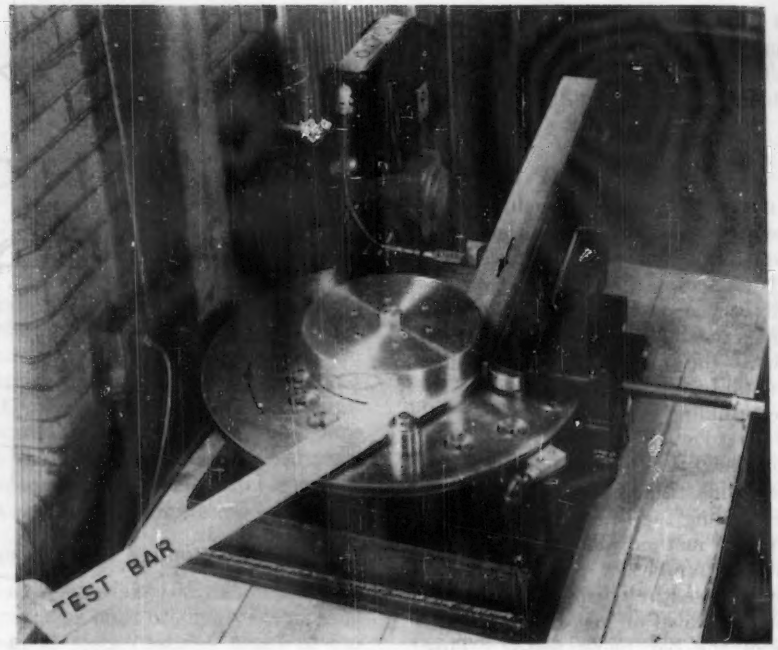

Fig. 2.—Bend-Testing Machine with Restraining Device, Showing Edgewise Bending of ¼ by 3-in. Bus Bar.

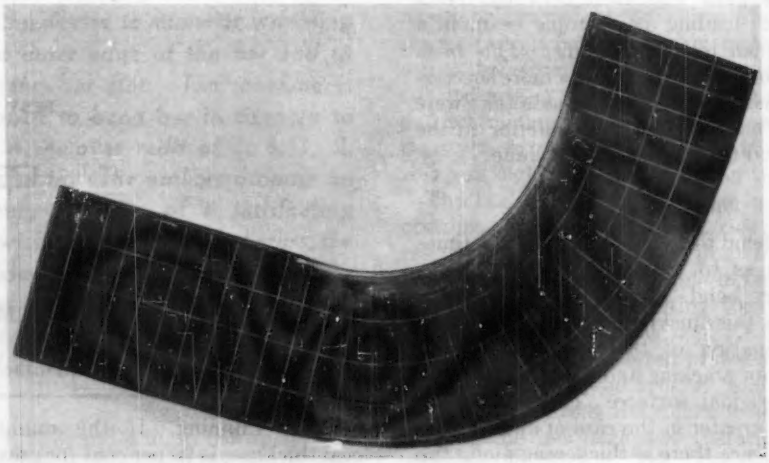

Fig. 3.—EC-H13 Aluminum Bus Bar, 5/16 by 2 in., Bent Around 2-in. Radius.

TABLE II.—RESULTS OF EDGEWISE BEND TESTS USING DIFFERENT WIDTHS OF SPECIMENS.

Specimen Width, in.	Ratio, Width to Thickness	Bend Radius						Smallest Satisfactory Bending Radius
		4 in.	3 in.	2 in.	1 in.	¾ in.	½ in.	
⅛-BY 3-IN. EC-H13								
3.....	24	F†	F	...	...	...	...	>1.3*W*
2.....	16	OK	F†	F†	...	...	...	2*W*
1.....	8	OK	OK	OK	OK	OK	F†	0.8*W*
¾.....	6	OK	OK	OK	OK	OK	OK	≷0.7*W*
$\frac{3}{16}$-BY 4-IN. EC-H17								
4.....	21.3	F	...	...	...	...	...	>1*W*
3.....	16	F	F	...	...	...	...	>1.3*W*
2.....	10.7	OK	OK	F	...	...	...	1.5*W*
1.....	5.3	OK	OK	OK	OK	F†	...	1*W*
¾.....	4	OK	OK	OK	OK	OK	OK	≷0.7*W*

NOTE.—The following symbols are used in the table:
W—width of specimen.
OK—satisfactory bend.
F—fractured.
F†—did not fracture but showed excessive localized deformation.

that with sufficiently reduced widths, specimens of these same bars could be bent satisfactorily around a radius of 1*W*. Actually, when the width was reduced far enough, specimens were bent around less than 1*W*. These tests indicate rather clearly that the ability of a bar to withstand edgewise bending is a function not only of its mechanical properties but also of the ratio of width to thickness of the specimen. Thus, by reducing the width of the bar sufficiently, a bar that could not be bent satisfactorily full size could be shown to meet the requirements of the specification. This defeats the purpose of the specification.

Conclusions

From the tests that have been described, the following conclusions seem warranted:

1. The testing machine that has been described has been found suitable for determining whether rectangular bus bar is capable of being bent edgewise satisfactorily. This does not mean, however, that the same bar could be bent successfully in manufacturing operations with less suitable equipment.
2. Bar that develops localized thinning when bent edgewise is satisfactory provided that the minimum local thickness is 90 per cent or more of the maximum thickness along the outer edge of the bend.
3. The ability of a bar of given thickness to withstand edgewise bending is a function of the width of the bar; therefore the use of specimens of reduced width is not satisfactory.

Acknowledgment:

The design of the bend testing machine described was conceived by R. L. Templin, Assistant Director of Research and Chief Engineer of Tests, Aluminum Company of America, whose assistance in this investigation is appreciated.

Discussion of Paper on Stress and Strain at the Onset of Crazing of Polymethyl Methacrylate

Mr. Bryce Maxwell.[2]—The subject of the crazing of polymeric materials has been of interest to the writer for several years. The question of whether or not a "critical strain theory" such as has been found applicable to polystyrene[3, 4] is equally applicable to polymethyl methacrylate is well worth investigation. This paper attempts to resolve this problem. The authors conclude that a critical strain is not a criterion for the onset of crazing in polymethyl methacrylate. There is no inherent reason why this material should behave in a manner similar to polystyrene. On the other hand, we should not conclude that it does not without making every effort by experiment and by careful interpretation of our data to test this criterion impartially.

Sherman and Axilrod have used a visual observation method of determining the onset of crazing. They say: "Inside the testing cabinet in the left rear corner was a lamp—a gooseneck desk type with hemispherical reflector—so placed as to permit observation of crazing as it developed on the specimen . . . . The plane of the flatwise surface of the specimen was perpendicular to the window." That is, the light source was not collimated and the specimen was not in the most desirable position for seeing the cracks. Observations of crazing with this type of arrangement would certainly be far from easily performed. In fact, the authors, in their concluding paragraph, mention that the lighting condition is a critical factor in determining the onset of crazing. This fact they support with evidence showing that using a somewhat different test setup and identical specimens, much lower strain at onset of crazing values was obtained at 23 C. In light of this fact one must wonder if we can draw definite conclusions from the data of the report.

The authors claim a trend of decreasing strain at the onset of crazing with increasing temperature (Fig. 5). Since the data for these strains at each condition have a range approximately equal to the variations found due to temperature and the data from the earlier tests made at 23 C show lower values approximately equal to those found at 50 and 75 C, we cannot help wondering if these strain values at the onset of crazing can be considered to show an actual trend.

One factor which should not be overlooked is the fact that crazing progresses more rapidly after initiation at higher temperatures. This makes crazing or the onset of crazing more easily observable at the higher temperatures; therefore, if a more precise and quantitative method of measurement of crazing such as has been used on polystyrene[3,4] were used in this study, some reduction in the strain at onset of crazing at 23 C might be found.

Another important factor in any study of crazing which the authors have not mentioned is the question of contamination of the specimen by organic materials either from fingerprints, direct contact with organic liquids, or contact with organic vapors in the air. Undoubtedly some precautionary measures were taken to prevent contamination. I would be interested to know what they were.

Mr. B. M. Axilrod (*authors' closure*).—It would be very interesting to measure strain at the onset of crazing of polymethyl methacrylate at various temperatures by both visual and instrument methods. This would demonstrate how the methods compare and would shed more light on the points in question.

The question was raised as to what measures were taken to avoid contamination of the specimens. The adhesive-coated masking paper which was on one side of the sheet and the plain paper which covered the other side were kept in place during storage, sawing, and dry machining. Protection was facilitated by pairing the sheets and specimens, with the plain paper faces in contact and tape across the ends to hold the pair together. Before conditioning the specimens for testing, the paper covering was removed and the surfaces cleaned by washing with tap water and, where necessary, rubbing with cotton to remove residual masking-paper adhesive. Contact with the fingers at the reduced section was avoided. The materials were stored and the specimens were stored, conditioned, and tested in a controlled atmosphere physical testing room.

[1] M. A. Sherman and B. M. Axilrod, "Stress and Strain at Onset of Crazing of Polymethyl Methacrylate at Various Temperatures," ASTM Bulletin, No. 191, July, 1953, p. 65 (TP109).

[2] Assistant Professor, Plastics Laboratory, Princeton University, Princeton, N. J.

[3] B. Maxwell and L. F. Rahm, "Rheological Properties of Polystyrene Below 80°C," *Industrial and Engineering Chemistry*, Vol. 41, No. 9, September, 1949, pp. 1988–1993.

[4] B. Maxwell and L. F. Rahm, "Factors Affecting the Crazing of Polystyrene," *Technical Report 14B*, Plastics Laboratory, Princeton University, Princeton, N. J., May, 1949; *Journal of Society of Plastics Engineers*, Vol. 6, No. 9, November, 1950, pp. 7–12.

Mechanical Testing and Inspection of Structural Adhesives

H. Grinsfelder,[1] B. Coe,[1] and R. P. Hopkins[1]

Expanding interest in structural adhesives has emphasized the importance of intelligent testing procedures both from the standpoint of developing commercially suitable adhesives and providing for reliable inspection on bonded assemblies.

The author treats of some elementary but basic factors involved in evaluating potential structural adhesives generally, including specific data for adhesives tested on polymethacrylate adherends and suggests a new approach to the problem of minimizing destructive testing in inspection procedures on bonded assemblies.

PERTINENT to the successful development of an adhesive for bonding structural members is a working knowledge of the variables which influence apparent strength. Important distinctions must be made between those limitations imposed by "intra" adhesive influential factors, such as heat or solvent resistance of the adhesives, and "extra" adhesive variables such as design of the glued joint or type of stress applied. Obviously, interrelationships exist between adhesive and adherend which either cannot be separated experimentally or are so specifically interrelated as to prohibit component analysis.

It is the purpose of this paper (*a*) to cite the influence of several factors which can affect the behavior of adhesives in a few of the more common mechanical tests in use today and (*b*) to discuss the application of statistical methods to adhesive testing, especially as a means of reducing the required number of destructive tests for structural adhesives.

Attention is also given to the need for considering possible ill effects of a "good" adhesive on the mechanical properties of the adherend.

Choice of Test and Test Specimen:

A prerequisite for any study of the mechanical strength of adhesives is a knowledge of the influence of different types of stress, as well as specimen constructions, or, as the construction engineer would say, different joint designs. Usually, the chemist seeking to develop an adhesive deliberately employs rather severe types of joints and stresses to get a conservative estimate of the failing strength of the adhesive. The engineer responsible for good joint designs usually employs conditions of more practical significance in testing bonded structures, rather than adhesives *per se*. Thus it is not uncommon to find the adhesive chemist and design engineer placing diametrically opposite emphasis on different types of test specimen constructions (or joint designs). As already implied, the present paper represents the viewpoint of the adhesive chemist.

Cleavage Tests:

The application of cleavage forces (a form of tensile loading) to a bonded specimen is about as severe a test as can be used in determining the ultimate strength of an adhesive. Standardized quantitative cleavage tests for bonds between two rigid (metal) members are available (ASTM Standard Method D 1062[2]) but the "bust them apart" technique, with knife or chisel, continues to be one of the most common qualitative tests for adhesives. In fact, a qualitative cleavage test has definite merit in the preliminary screen testing of potential adhesives without extensive fabrication of specific types of test specimens. We have found qualitative cleavage tests to be a good means of screening influential variables, such as surface condition requirements as well as adhesive shrinkage effects responsible for "let-go's." It is important to realize, of course, that adhesives having certain particularly desirable qualities (fast bonding speed, ease of handling, etc.) but only fair cleavage strength should be tested under less severe conditions before being dropped from consideration. Cleavage strength weaknesses can frequently be minimized or eliminated by the design engineer.

Table I contains an example of the use of qualitative cleavage tests to define the type of surface preparation necessary for bonding polymethylmethacrylate sheet with an experimental adhesive. Laminates, 3 by 6 in. in size, were prepared for this test, separation being attempted by insertion of a knife blade into the glueline.

TABLE I.—CLEAVAGE TESTS TO DEFINE SURFACE PREPARATION REQUIREMENTS.

Type of (Poly MMA) Surface	Cleavage Strength
Untreated	Poor
No. 280 sandpaper	Excellent
No. 2 emery sandpaper	Excellent
Sand blasted	Excellent

Tension Tests:

One of the most useful and informative tests for adhesives involves a butt joint (end to end) stressed in direct tension. Among its virtues are relative ease of preparation and relative freedom from eccentric variables in the stressing of the specimen. Thus tension testing permits ready evaluation of many potential variables affecting the adhesive, for example, temperature and glueline thickness. As a general rule, the apparent mechanical strength of an adhesive under shear stresses is conservatively underestimated by the more severe butt joint tension tests. In fact the greater severity of direct tensile stressing (second only to cleavage) is responsible for the common engineering practice of loading a joint in shear rather than in tension, wherever possible.

Shear Tests:

Shear test data, in terms of tension shear or compression shear on lap joints, are undoubtedly of more value to the design engineer than to the adhesive chemist. The inherent strength of the adherend and the dependence of maximum shear stress on the thickness of the adherend are two variables which enter into testing the adhesive variable itself. As will be shown later, sufficient variables are at work even in tension tests without including extraneous variables.

Modern synthetic resin adhesives frequently find use in wood, plastics, etc., where they exceed the strength of such adherends in conventional tension shear or compression shear tests. "Greater than *X*" values are abstract and there-

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[1] Adhesives Applications Laboratory, Research Div., Rohm and Haas Co., Philadelphia, Pa.

[2] Method of Test for Cleavage Strength of Metal-to-Metal Adhesives (D 1062 – 51), 1952 Book of ASTM Standards, Part 7, p. 1011.

fore prevent analysis of data necessary to ascertain variables affecting adhesive performance. Frequently, only in the case of metals can certain adhesives be tested to failure in shear, but even here failing stresses are influenced by the thickness of the adherend. De Bruyne has made this quite clear in establishing a relationship between the strength of a lap joint (not strength of the *adhesive per se*) and geometry of the joint, which he calls the "joint factor" (**1**).[3]

Experimental Work:

Based on the concept that butt-jointed specimens when tested in tension provided a method of causing the adhesive to fail rather than the adherend, different types of adhesive were studied as possible bonding agents for a cast acrylic polymer. The variables encountered are essentially those which could be encountered in any particular mechanical test over and above those inherent in the test itself.

Sample-to-Sample Variations of Adherend:

The adage "one swallow doesn't make a summer" has a corollary in "one test doesn't make an adhesive." Before any attempt can be made at describing the adhesive strength of a product with a reasonable degree of accuracy, replicate tests on the more obvious possible variables are necessary. The variability of a particular adherend should be assessed early in adhesive testing. This adherend variability can express itself in different panels from a given batch of polymer or in different batches of the adherend. The within-a-batch (panel-to-panel) variation can be statistically analyzed simultaneously with reference to batch-to-batch variation of adherend by an analysis of variance.

The data in Table II, involving three panels from each of three batches of adherend, were analyzed statistically and it was found that no significant difference existed in the data, that is, the mean values and dispersion of the data from batch to batch and within a batch of adherend were of the same magnitude.

TABLE II.—PANEL-TO-PANEL AND BATCH-TO-BATCH VARIATIONS OF ADHEREND.

Batch of Poly MMA	Tensile Strength, psi	Standard Deviation, psi	Coefficient of Variation, per cent
A...	3855	700	18.2
B...	4290	860	21.1
C...	4560	715	15.8

Note—The standard deviation was calculated for each of the three panels (5 specimens each) and then averaged.

[3] The boldface numbers in parentheses refer to the list of references appended to this paper.

Other Variables Within a Given Test:

Having obtained a measure of the variability of the adherend, it is of definite value to estimate the amount of reproducibility on repeated tests conducted at different times. Day-to-day variation was studied by testing two different adhesives on each of two different batches of adherend, repeating the bonding twice. The data in Table III were subjected to an analysis of variance. This familiar statistical tool is of particular value in being adaptable to studying possible differences among more than two variables as well as interactions between two or more variables. In the present case, analysis of variance was used to examine day-to-day variation and to compare two adhesives.

It was determined that a significant day-to-day variation existed in efforts to describe the tensile strength of the two adhesives. No other variables were found significant on the number of observations made.

Development of a Screen Test for Adhesives:

A statistical appraisal of possible factors affecting the mechanical testing of adhesives, in a manner similar to that briefly reviewed, provides an intelligent basis for adhesive evaluations. Following the selection of a particular type of mechanical test of most interest for the adhesive in question, a hypothesis should be established concerning the more important potential variables which might affect the testing.

An adhesive is as strong as its lowest value, but inspection of the data alone cannot significantly establish what the value is or what the factors are that control it. Based on this concept a screen test was developed for a structural adhesive for polymethylmethacrylate from the information already described. Having eliminated different batches of adherend as a variable, but recognizing the day-to-day reproducibility problem, usually two adhesives were each tested on three panels (five specimens per panel), on each of three different days before any weight was given to the strength values obtained. Strength values were naturally first determined at room temperature. Those giving satisfactory strength on this screen test were subsequently studied at other detailed conditions.

The technique of identifying important factors affecting mechanical tests, by applying statistical procedures, is simply another extension of the current trend in using statistics in research. The use of such methods as analysis of variance presupposes experimental design and therefore replaces the hit-or-miss approach to adhesive tests. Those who have had the misfortune of ascribing certain strength values to an adhesive, only to be refuted by additional testing, very often are the victims of a characteristic variation of the product, readily defined in statistical studies.

Adhesive-Adherend Effects on Mechanical Strength:

The tide of favor which has swept synthetic resin adhesives into rightful prominence has on occasion failed to recognize ill effects produced by certain adhesives on the substrate. Some deleterious effects on wood have been pointed out as originating in (highly acid) resin adhesives (**2**), but little specific information has been published concerning similar effects on other types of adherends.

In our investigation of adhesives for experimental polymers of methyl methacrylate, particularly those for which solvent cements are unsuitable, a resorcinol resin was found to exhibit excellent adhesion in tension tests, but under certain conditions notch sensitizing effects were produced on the adherend.

TABLE III.—VARIABLES OF TIME OF TEST, BATCH OF ADHEREND, AND TYPE OF ADHESIVE.

	Adhesive A		Adhesive B	
	Average Tensile Strength, psi	Standard Deviation, psi	Average Tensile Strength, psi	Standard Deviation, psi
ADHEREND A				
Day 1.....	3880	670	4514	390
Day 2.....	4590	720	5010	470
Day 3.....	3850	740	2830	440
Average.....	4105	707	4119	430
ADHEREND B				
Day 1.....	4480	480	4140	1320
Day 2.....	5190	890	4530	570
Day 3.....	3570	930	3745	620
Average.....	4411	767	4140	837

NOTE.—The standard deviation was calculated for each of the two panels (5 specimens each) and then averaged

TABLE IV.—EFFECT OF TWO RESINS ON THE MECHANICAL PROPERTIES OF EXPERIMENTAL POLY MMA.

Adhesive Coating	Unnotched Charpy Impact, ft-lb (½ by ½-in. Section)	Flexural Strength, psi	Flexural Deflection, in. (at Break)
None	3.17	15 160	0.46
Epoxide	1.27	10 510	0.19
Resorcinol-formaldehyde ratio	0.98	6 170	0.11

Notch sensitivity was also induced by an epoxide resin. A series of tests made on the tensile strength of the cast acrylic sheet shows this effect quite well in Table IV. For this work the resorcinol and epoxide samples in question were simply coated lightly on the surface of standard specimens and compared to a control.

Following this finding, it was considered essential to include some method of quickly checking potential adhesives (for the experimental acrylic) for such stress concentration effects. Because of the transparent nature of the adherend, polarized light was effectively used in this type of test. The procedure involved spreading a film of adhesive, about ¼ to ½ in. wide, across one side of a ¼ by 1 by 6-in. specimen. A variety of adhesives were cured at proper conditions and the adhesive-coated adherend then viewed edgewise between crossed polaroid lenses. To assure the validity of this test, the same samples were loaded in tension and observed for the point of fracture. Typical results are summarized in Table V.

Failures at low tensile strengths, occurring beneath the resin-coated surface, correlated with polaroid light indications of stress concentrations.

Importance of Tests for Adhesive-Adherend Effects on Mechanical Strength:

The preceding data constitute evidence of the hazard involved in ignoring possible stress concentration effects produced by an adhesive on a substrate. Two adhesives may possess comparable bond strength, but should one of them tend to notch-sensitize the adherend, it is a potentially objectionable engineering material. This has been found particularly true where glue "squeeze out" of sensitizing resins occurs. As shrinkage or cure continued, cracking occurred within the adhesive, followed by cracking of the acrylic adherend adjacent to it.

Pseudo Non-destructive Statistical Tests for Structural Adhesives:

The foregoing discussion has traced adhesives testing from necessary elementary knowledge of the variables of type of stress through the influential factors of a given test, to adhesive adherend interrelationships. An adhesive that has been characterized as being satisfactory for commercial use after such study should ideally permit control tests which do not destroy it.

In the testing and evaluation of adhesively bonded joints, the problem of determining conformance of the bond to a specified value without either (*a*) destroying the joint or (*b*) testing a majority of the parts submitted under the specification contract has been a troublesome one for a long while. A variety of testing devices have been developed during recent years for meeting this challenge. Most of these new test instruments have been based on ultrasonic measurements (for detecting flaws) or electrical measurements (for determining degree of cure of resin adhesives (3)). Neither approach has as yet received widespread acceptance.

A recently published article (4) has suggested the possibility of using a new statistical approach, called Tests of Increased Severity, for handling problems of this type. In this particular approach, the frequency distribution of a lot that gives satisfactory performance and meets the requirements of the specification is determined rather completely. Then, depending on the purpose of the inspection plan, one of three sampling and test plans, all of which are aimed at reducing the amount of tests, is selected for adoption. In the simplest one, the test load that would cause failures to occur in 50 per cent of the specimens is selected as the quality control criterion. Then, other batches of material supplied as meeting the requirements of the specification are sampled sparingly and tested at this so-called increased severity level of 50 per cent. Due to the shape of the normal distribution curve, testing at this load is more definitive as to good and bad lots than is testing at the design level.

By way of illustration, tests on 69 random samples of an acceptable lot of an adhesively bonded structural part, following an exposure condition known to accelerate deterioration reliably were obtained.

Using the method of presentation of data as recommended by the ASTM (5), the results can be arranged as shown in Table VI.

TABLE VI.—CUMULATIVE RELATIVE FREQUENCY.

Tensile Shear Strength, psi	Percentage of Bonded Joints Having Strength Greater than Indicated Value
235	100.0
275	97.1
315	81.4
355	52.9
395	35.7
435	15.7
475	2.9
515	0.0

These data may be plotted on log probit paper as illustrated in Fig. 1. Simplicity in obtaining a linear plot is one reason for preferring log probit paper as compared to arithmetic probit paper. Using the graphical method of Litchfield and Wilcoxon (6) or the more accurate but involved method described by Churchman and Epstein (4), the mean critical stimulus (the so-called 50 per cent failure level) is estimated to be 370 psi. Incidentally, the standard deviation of the data may be determined from the slope of the line since it is its antilogarithm.

Based on these results, let us assume that it was agreed between buyer and seller that (*a*) an acceptable lot is one which has 0.1 per cent failures or fewer at the stimulus giving 0.1 per cent failures in the standard lot, which was 240 psi, (*b*) an unacceptable lot is one which has 1 per cent failures or more at the 240 psi test load, (*c*) marginal lots are those which give between 0.1 and 1 per cent failures. Additionally the producer was willing to accept a 5 per cent risk of having a good lot rejected, while the buyer was willing to take only a 1 per cent risk of his accepting an off-grade lot. It can be calculated by sequential analysis (7) that on the average 628 specimens need to be tested for accepting a lot having 0.1 per cent defectives at the 240 psi load, and 206 specimens are needed for test to reach a decision on lots having 1 per cent failures.

TABLE V.—RELATIONSHIP BETWEEN MECHANICAL FAILURE AND VISIBLE STRAIN ON RESIN-COATED ADHEREND.

Type of Resin	Tensile Strength, psi	Polaroid Strain	Place of Failure
Furane	8630	None	Machine grips
Epoxide A	8650	None	Machine grips
Epoxide B	8030	Appreciable	Resin-coated area
Resorcinol A	4160	Appreciable	Resin-coated area
Resorcinol B	5090	Appreciable	Resin-coated area
Polyester	8350	None	Machine grips
Control	8490	None	Machine grips

NOTE.—One specimen per test.

Now the point beyond which 1 per cent of the area under the normal curve lies is 2.33 times the standard deviation and for 0.1 per cent is 3.09 times or a difference of 0.76 (8).[4] Translating the problem to its increased severity analogue to be carried out at the stimulus giving 50 per cent failures in the standard lot (370 psi), we find that all but 22 per cent (78 per cent failures) will appear in a lot having 1 per cent defectives, since that is the area under the normal curve at a distance of 0.76 standard deviation from the mid-point.

Thus, a comparison between lots having 0.1 and 1 per cent defectives at the specification stimulus is converted to a comparison between lots having 50 and 78 per cent defectives at the increased severity stimulus. It can be calculated again by means of sequential analysis that a decision will be reached as to acceptance or rejection of the lot after 22 tests have been made if the lot contains 50 per cent defectives and after 18 tests if it contains 78 per cent defectives.

It is occasionally difficult to characterize and thus to approve or reject lots solely on the basis of their passing or failing the increased severity test conducted at the 50 per cent level. In addition to the results obtained at the one load level or mean critical stimulus, a more complete knowledge of the distribution curve of the lot in question is then desired or even required. This is undertaken when it is found or suspected that the distribution curve of the lot under question is different from that of the standard lot, even though they may have the same response to the 50 per cent load. In other words, it is possible for two lots to behave similarly at the 50 per cent failing load level, but not at the 40 per cent, 60 per cent, or other levels of testing.

In order to determine this over-all similarity, it is necessary to obtain an estimate of the standard deviation and hence the distribution curve of the lot. The authors have suggested either of two methods for making this determination. Both are of use and value in approving or rejecting lots. While they do require more testing than in the method using only the mean critical stimulus, they still are conservative as to the number of tests required for reaching decisions (as compared to making the test at the specified requirement only).

In the one instance, an estimation of the distribution of results is obtained by testing at two or three levels of increased severity. In the other instance, which is merely a refinement of the first one, testing is conducted over a more complete number of load levels. The principal disadvantage of the first method is that of lack of accuracy, particularly far out on the tails of the distribution curve.

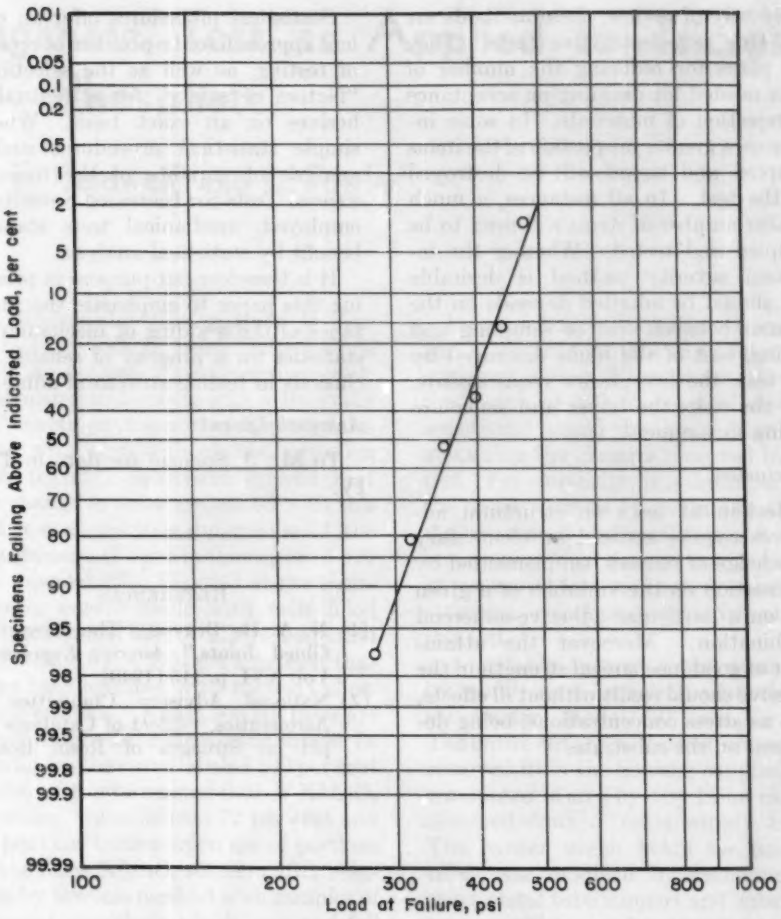

Fig. 1.—Log-Probit Plot of Tension Shear Data.

These more critical types of increased severity tests would be useful in testing against accepting a lot with an extremely small fraction defective. Such critical items as bonded brake shoes, clutch assemblies, aircraft components, and others where engineering design, economy, and human safety are closely related fall in this category.

As an example, a manufacturer may want to take no more than a 50-50 chance that a bonded part will possess no more than 3 defectives in 10 million items. If the parts are tested at the specified load level, as many as 100,000 parts may need to be tested to decide whether to accept or reject the part. If the parts are tested by either of the two stimulus tests or by the complete run-down method, it may be calculated and shown that testing of about 300 to 350 parts is all that is needed to reach the same highly critical decision.

By adoption of the same principles it is pointed out that "factors of safety" may be set on an exact basis. For example, suppose we know that a bonded structural part has been so designed that it will never receive a load greater than 1500 psi in actual service. It is desired to know what value should be set for test purposes to make sure that all pieces will support such a load. The value 1500 psi should not be chosen as the load, for any sampling plan, except 100 per cent inspection, possesses error. Rather than select 2000, 2500, or 2800 psi as is often done on a vague guess as to the adequacy of the safety margin, the product should be tested to obtain an estimate of the highest standard deviation to be expected and to choose a value which exceeds 1500 psi by more than 1.25 the standard deviation. The value 1.25 is obtained from a plot of probability of acceptance against the stimulus where only three defectives in ten million occur. This plot shows that practically no lot will be accepted, the stimulus of which exceeds the "specification stimulus" by 1.25 the standard deviation.

[4] Churchman and Epstein (4) state: "The fact that $\bar{x}$ and s approach normality rapidly as function of N, the number tested at each stimulus, has been established by the authors. The results have not yet been published."

By way of review, these methods are not true non-destructive tests. They are plans for reducing the number of tests needed for deciding on acceptance or rejection of materials. In some instances, a greater proportion of the items sampled and tested will be destroyed by the test. In all instances, a much smaller number of items will need to be sampled and tested. Whether the increased severity method is desirable and should be adopted depends on the balance between cost of sampling and testing, cost of the items destroyed by the test, the acceptance requirements, and the risks the buyer and seller are willing to assume.

Conclusion:

Mechanical tests on structural adhesives require at least an elementary knowledge of stresses, supplemented by information on the variables of a given test on a particular adhesive-adherend combination. Moreover the attainment of good mechanical strength in the adhesive should result without ill effects, such as stress concentrations, being developed on the substrate.

Statistical procedures offer an excellent approach to the problem of economy of testing, as well as the selection of "factors of safety" for structural adhesives on an exact basis. Whether simple statistical procedures such as analysis of variance or the more advanced Tests for Increased Severity are employed, mechanical tests stand to benefit by statistical analysis.

It is therefore our purpose in presenting this paper to emphasize the importance of the wedding of mechanics and statistics for a progeny of reliable conclusions in testing structural adhesives.

Acknowledgment:

To Mr. J. Spencer for data in Table IV.

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Discussion of Paper on Fatigue Strength of Steels and Light Alloys[1]

MR. GEORGE L. JENKINS.[2]—Wyss has shown that for some conditions fatigue strength is not greatly affected by testing frequency but appears to be somewhat greater at higher frequencies. However, Wyss does not offer a physical explanation of why a higher fatigue strength might be expected at higher frequencies.

It seems logical to assume that fatigue failure is at least partially due to slip.[3] If a specimen is loaded in an extremely short period of time (approaching zero) and immediately unloaded there will not be sufficient time for slip to occur, and elastic action can be expected.[4] Experiments with the propagation of sound waves in a plastic bar indicate that times associated with the speed of sound are so short that little slip occurs.[5] Thus, at very rapid testing frequencies one might expect a reduction in slip and a corresponding increase in fatigue strength.

The steels tested by Wyss tend to show a definite correlation between per cent elongation and fatigue strength. Materials with the least elongation show the least sensitivity to testing frequency. Since elongation is a measure of slip, one would expect this correlation if the above theory is correct. The one aluminum alloy containing zinc is in disagreement with this theory, but the experiments[1] scatter of the aluminum specimens was far greater than that of the steels.

If the highest testing frequency used by Wyss was so fast that not all slip occurred, it might be expected that additional increases in frequency would cause additional increases in fatigue strength. This effect could be very nonlinear, that is, it might be dangerous to attempt extrapolation beyond the highest frequency tested.

In most metals the plastic strain corresponding to a given stress level becomes more and more a function of time as temperature is increased. Therefore, fatigue strength might be much more a function of testing frequency as temperature is increased. This tendency could be offset by the greater tendency of the metal to rebond at elevated temperature. It would be interesting to see the results of tests to determine which effect predominates.

[1] Th. Wyss, "Influence of Testing Frequency on the Fatigue Strength of Steels and Light Alloys," ASTM BULLETIN, No. 188, February, 1953, p. 31 (TP23).

[2] Research and Development Laboratories, Hughes Aircraft Co., Culver City, Calif.

[3] F. R. Shanley, "A Theory of Fatigue Based on Unbonding During Reversed Slip," *Report No. P-350*, The Rand Corp. (1952).

[4] F. R. Shanley, "Weight-Strength Analysis of Aircraft Structures," McGraw-Hill Book Co., New York, N. Y. (1952).

[5] James Fredrick Bell, "Propagation of Plastic Waves in Pre-Stressed Bars," *Technical Report No. 5*, The Johns Hopkins University, Baltimore, Md., June, 1951.

The Potassium Permanganate Test as Applied to Tricresyl Phosphate[1]

By J. E. Caldwell[2] and L. Fowler[2]

For about 20 years the potassium permanganate or oxidizable substances test has been included in various specifications as a sensitive check on the purity of tricresyl phosphate. An early appearance was in ASTM Tentative Specifications and Tests for Tricresyl Phosphate (D 363–33T).[3] It remains in unaltered form in the latest revision, Standard Specifications for Tricresyl Phosphate (D 363 – 49),[4] and appears in substantially identical form in other specifications such as Federal Standard Stock Catalog TT-T-656.[5]

As usually described,[6] the procedure to be followed calls for agitating 10 g of the phosphate ester with 50 ml of freshly prepared 0.01 *N* $KMnO_4$ solution. To "pass" the test, the $KMnO_4$ solution should show no change in color after standing 30 min. The color change of concern is one from the purple $KMnO_4$ color to a reddish purple color. It is probable that this change is due to the formation of small amounts of finely divided MnO_2 from the oxidation of trace impurities. The interpretation of the test then requires a subjective judgment of color differences which will be influenced by such factors as lighting conditions. Such a subjective test is of limited use as a comparative purity test. The authors have found that the test can be quantified and made more meaningful by measuring the color change of the $KMnO_4$ solution with a photoelectric photometer. This has also made it possible to express quantitatively the influence of contaminating unreacted phenols and of phosphites, to both of which the test is very sensitive. As a result it has been found that the usual test for such free phenols is inaccurate, and the inclusion of such a test in a specification for this material is misleading as well as being incompatible with the potassium permanganate test.

Measurements made with a Beckman DU spectrophotometer of $KMnO_4$ solutions with and without the agitation with tricresyl phosphate showed that the change in color associated with this test is confined to a diminution of the transmission of light in the region of 420 mμ wave length. Figure 1 shows transmission curves made with cells filled with unreacted 0.01 *N* $KMnO_4$ solution and with 0.01 *N* $KMnO_4$ solutions that have been agitated with tricresyl phosphate samples. Above 500 mμ there are no significant differences in the curves. In this figure, the curve labeled 100 per cent is that of the unreacted 0.01 *N* $KMnO_4$ solution; those labeled 72 per cent and 34 per cent transmission are of portions of the same $KMnO_4$ solution after reaction by the test method with samples of tricresyl phosphate which pass and fail the test, respectively. The significance of the difference between the curves and of their labeling is discussed below.

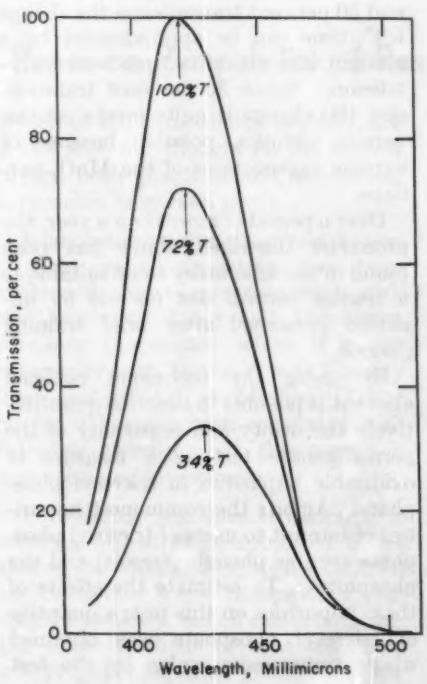

Fig. 1.—Light Transmission of Potassium Permanganate Solutions With and Without Treatment of Tricresyl Phosphate Samples.

From an examination of the curves in Fig. 1, it is evident that any photometer equipped with a filter transmitting in the region of 420 mμ and of suitable sensitivity would be appropriate for measuring the changes observed in this test. For simplicity, it is desirable that the measurements be made directly on the reactant $KMnO_4$ solution and without removal from the reaction vessel. It is necessary also to keep in mind the stringent cleanliness requirements of this test.

A suitable apparatus was assembled by modifying a Lumetron photoelectric colorimeter, Model 401 (see Fig. 2).[7] The entire chassis of the instrument was removed from the housing supplied and remounted in an 8 by 8 by 14-in. cabinet obtained from a radio supply house. The carrier which holds the solution tubes was modified by removing the sheet metal tube support and substituting one which permitted the tubes to be inserted to a depth of about 6 in. (see Fig. 3). No other changes were necessary, and the operation of the instrument follows the manufacturer's directions. Suitable reaction tubes were prepared from 22 mm OD Pyrex tubing cut about 8 in. long sealed at one end and with a ground-glass stopper sealed on the other end. When these tubes have been filled with the required amounts of the two liquids and inserted in the modified instrument, the interface between the ester and aqueous layers comes well below the light path. It was found that tubes made from a single length of tubing matched within ± 1 per cent transmission when filled with 0.01 *N* $KMnO_4$ solution, which is quite adequate for the purpose at hand. The No. 420 filter supplied with the instrument was found to have a transmission curve almost identical with that of $KMnO_4$ solution and is entirely suitable for use in this test.

In practice, to one reaction tube is added the tricresyl phosphate and the $KMnO_4$ solution. These are mixed by repeated inversions and after the lapse of 30 min the tube is placed in the "sample" hole of the tube carrier. Into the "blank" hole, a tube containing only the 0.01*N* $KMnO_4$ solution is inserted.

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[1] Presented at a meeting of Committee D-20 on Plastics held in Atlantic City, N. J., September 30, 1953.

[2] J. F. Queeny Plant, Monsanto Chemical Co., St. Louis, Mo.

[3] 1933 Book of ASTM Tentative Standards, p. 510.

[4] 1952 Book of ASTM Standards, Part 4, p. 359.

[5] Paragraph E-2e.

[6] Standard Methods of Sampling and Testing Lacquer Solvents and Diluents (D 268 – 49), 1952 Book of ASTM Standards, Part 4, p. 417.

[7] Photovolt Corp., New York, N. Y.

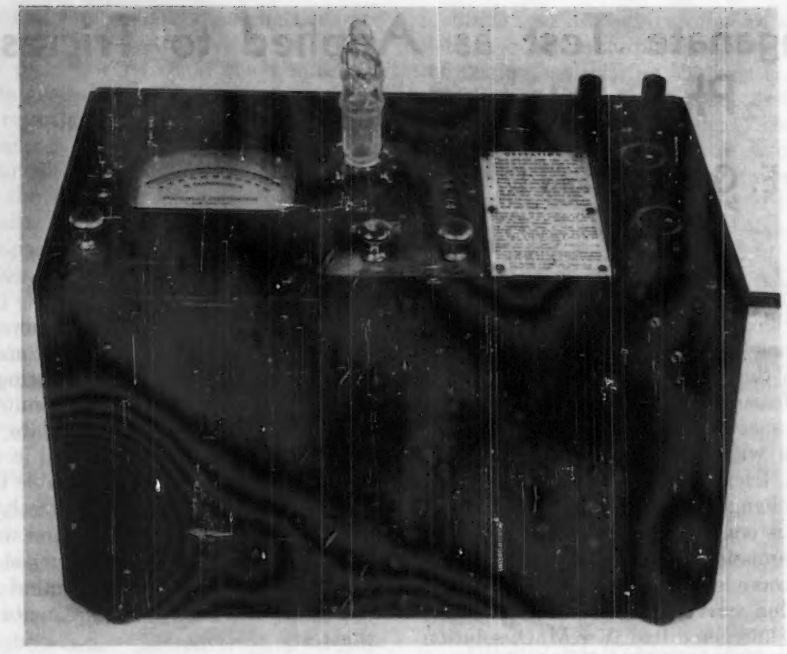

Fig. 2.—Lumetron Photometer Modified for Potassium Permanganate Test.

Then the instrument is adjusted to read 100 per cent transmission with the $KMnO_4$ solution tube in the light path. The tube carrier is moved to insert the sample tube in the light path, and the per cent transmission is read. The samples used in preparing the solutions from which the curves in Fig. 1 were made were thus tested. The per cent transmission identification of the curves in the figure are the resultant readings. Readings made with the Beckman instrument at the 420 mμ maximum agree within 1 per cent transmission with the Lumetron values.

Other photometric devices could be used for this test. In addition to the Beckman instrument, a trial was made with the Fisher Electrophotometer. Both instruments are optically and electrically satisfactory but require transfer of the $KMnO_4$ solution and require more involved and painstaking operations than the modified Lumetron instrument described above.

When a variety of samples was tested by this photometric procedure and the results compared to the subjective judgments of a group of experienced observers, it appeared that materials giving values of less than 60 per cent transmission by this test were uniformly called "changed." Those samples giving values of more than 70 per cent were uniformly called "unchanged." Most observers were not able to discriminate between samples whose colors were closer than ± 5 per cent transmission. The reproducibility of the instrument readings is better than ±1 per cent transmission. Successive reactions on 10-g portions of single samples of tricresyl phosphate showed a standard deviation of 3 per cent for the 30-min transmission reading on any one portion.

The variation of the transmission readings with time during the 30-min time lapse of the test is somewhat erratic. The results with most samples showed a leveling off of transmission with time. Over the range between 100 and 50 per cent transmission the change with time can be approximated by a straight line within ±5 per cent transmission. Below 50 per cent transmission the change is quite erratic among various samples, possibly because of varying aggregations of the MnO_2 particles.

Over a period of more than a year, the procedure described above has been found in our laboratory to be suitable as a routine control test for use by unskilled personnel after brief training periods.

By using the technique outlined above it is possible to describe quantitatively the utility and sensitivity of the permanganate test as a measure of oxidizable impurities in tricresyl phosphate. Among the commonest impurities of interest to users of tricresyl phosphate are free phenols (cresols) and the phosphites. To estimate the effects of these impurities on this test, a quantity of tricresyl phosphate was obtained whose transmission value by the test was 95 per cent transmission. To portions were added various amounts of meta-cresol, commercial cresylic acid, or triphenyl phosphite and the test procedure applied. The results are given in Table I.

TABLE I.—EFFECT OF IMPURITIES ON PERMANGANATE TEST.

Sample	Transmission, per cent
Original TCP	95
Added 0.01 per cent m-cresol	75
Added 0.02 per cent m-cresol	62
Added 0.03 per cent m-cresol	44
Added 0.05 per cent m-cresol	26
Added 0.01 per cent cresylic acid	74
Added 0.02 per cent cresylic acid	50
Added 0.03 per cent cresylic acid	34
Added 0.05 per cent cresylic acid	14
Added 0.01 per cent triphenyl phosphite	78
Added 0.02 per cent triphenyl phosphite	72
Added 0.03 per cent triphenyl phosphite	66
Added 0.05 per cent triphenyl phosphite	53

It is evident that the test is very sensitive to small amounts of these impurities, as little as 0.02 per cent (*w/w*) of free phenols or 0.04 per cent (*w/w*) of phosphites being enough to cause the material to "fail" by this test.

Table I shows an obvious correlation between the amount of free phenols present and the per cent transmission figure. Since there is a standard procedure customarily used to estimate the amount of free phenols in commercial tricresyl phosphate,[8,9] it is of interest to compare the results obtained thereby with the results of the potassium permanganate test.

The usual free phenols determination involves extracting the ester with 2.5 per cent NaOH solution at 65 C and determining the bromine absorption of the aqueous extract, assuming the addi-

[8] Standard Methods of Sampling and Testing Lacquer Solvents and Diluents (D 268 – 49), 1952 Book of ASTM Standards, Part 4, p. 418.
[9] Federal Standard Stock Catalog TT-T-656, Paragraph F-2e (1949).

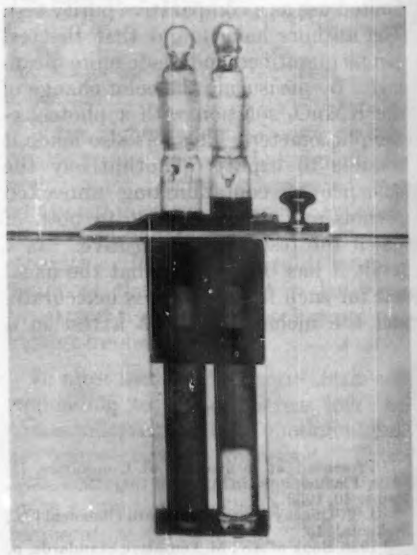

Fig. 3.—Sample Holder for Modified Lumetron Photometer Showing Sample Tubes with Unreacted $KMnO_4$ Solution and Reacted $KMnO_4$ Solution in Contact with a Tricresyl Phosphate Sample.

tion of three bromine atoms per molecule of cresol.

It might be expected that there is some danger of partial hydrolysis of the ester in this process. To test this possibility, 10-g portions of various samples of commercial tricresyl phosphates were successively extracted with 50-ml portions of 2.5 per cent NaOH at 65 C by shaking vigorously for the designated 3 min. The water layers were diluted to 250 ml. filtered, and 100-ml aliquots treated with 15 ml of bromide-bromate reagent (10.09 g NaBr and 2.95 g $NaBrO_3$ per l), 5 ml concentrated HCl, mixed and allowed to stand 15 min. Then 10 ml of KI solution (6 per cent *w/v*) was added, and the solutions titrated to the starch end point with 0.05 *N* NaS_2O_3.

Table II shows the results of a straightforward application of the free phenols test procedure to several commercial samples as compared with the potassium permanganate test results. Table III shows the results of the reiterated extractions just described compared with the potassium permanganate test results on a similar group of samples.

Apparently there is an extraction blank in this procedure of 0.01 to 0.02 per cent apparent free phenols. By use of a benzene diluent for the tricresyl phosphate and 1 per cent cold NaOH solution extract, the blank could be reduced to about 0.006 per cent and the apparent free phenols content on the first extract reduced by 0.01 to 0.02 per cent. This did not, however, eliminate the fact that there is a discrepancy between the free phenols test and the potassium permanganate test. Not only do the data in Tables II and III show on comparison with the data in Table I that there is actually less than 0.02 per cent free phenols in each sample, but it will be observed that there is no correlation between the two tests, whereas the data in Table I show such a correlation between the true free phenols content and the per cent transmission. The cause of this discrepancy is not completely clear, but it is undoubtedly partially due to hydrolysis by the alkaline extraction medium used in the free phenols test. Also there is a real possibility[10,11] of brominating the side chains of the cresols, xylenols, and ethylphenols which make up commercial cresylic acid. In any event, it is apparent that it is improper and redundant to include the free phenols test in a specification which includes the potassium permanganate test when the intrinsic inaccuracy of the former test is of the same order of magnitude as that which would cause failure by the latter test.

TABLE II.—FREE PHENOLS AND PERMANGANATE TEST ON COMMERCIAL TRICRESYL PHOSPHATE.

Sample	Free Phenols, per cent	$KMnO_4$ Test, Transmission, per cent
A.....	0.03	92
B.....	0.05	78
C.....	0.07	86
D.....	0.10	82

TABLE III.—REITERATED FREE PHENOLS TEST.

Sample	Transmission, per cent	Free Phenols, per cent			
		Extract 1	Extract 2	Extract 3	Extract 4
E..	83	0.092	0.021	0.021	...
F..	87	0.055	0.016	0.013	...
G..	75	0.086	0.017	0.018	0.027
H..	77	0.036	0.014	0.009	0.009

As a safeguard against excessive free phenols content, the potassium permanganate test is patently superior on the grounds of simplicity and sensitivity. Its use makes the inclusion of the free phenols test unnecessary, while the reverse is not true.

In summary, a method has been devised for quantifying the standard potassium permanganate test applied to tricresyl phosphate. Subjective judgments are thus eliminated and more precise comparisons of materials by this test made possible. It has been shown that the test is very sensitive to most impurities—more so in the case of the free phenols content than the usual test applied for this impurity.

[10] M. M. Sprung, "Bromination of Phenols by Means of Bromide-Bromate Solution," *Industrial and Engineering Chemistry*, Analytical Edition, Vol. 13, p. 35 (1941).

[11] A. W. Francis and A. J. Hill, "Bromination of Phenols by Means of Bromide-Bromate Solution," *Industrial and Engineering Chemistry* Analytical Edition, Vol. 13, p. 357 (1941).

Discussion of Paper on Pumpability of Residual Oils[1]

MR. R. J. RUSSELL.[2]—In our opinion this paper represents a distinct advance over previously published work on fuel pumpability, it being the first time of which we are aware when testing procedures intended to predict fuel oil pumpability have been evaluated in the light of actual pumping trials. Our own experience indicates that results obtained on one type of fuel may not be repeated with other materials. Before the conclusions concerning tests of the type carried out by Messrs. Shipp and Tredick can be considered as well grounded, work on oils of widely differing type is required. However, in spite of the restricted number of oils used, the five conclusions drawn by the authors, using an essentially practical approach to the pumpability problem, are in line with our thought on the subject (where both practical and theoretical approaches have been used).

A laboratory test method based upon a yield value procedure has been evolved during cooperative work with the Admiralty Fuels and Lubricants Advisory Committee, which it is felt is superior both to the P & O Fluidity Test and to ASTM Method D 97.[3] So far it has not been correlated with full-scale practice, but this aspect is now receiving investigation.

Considering the heat treatment to which a fuel must be subjected before testing for pumpability, we feel that, for indicating the worst pumpability condition to which a fuel oil can deteriorate, the latest methods of heat treatment are probably of more general application than those of SVM 201 – 50. However, we know of no evidence to indicate that in commercial storage the worst pumpability condition is in fact ever reached; most of our evidence indicates that an intermediate condition of pumpability, between worst and best, is likely. We therefore feel that a statistical examination of fuel oil from a large number of installations is required in order that a practical and representative fluidity level may be set as the target for the laboratory heat treatment of fuel oils.

The only point in the paper which we would modify is the suggestion that it is far harder to start up a line on heating from cold than during cooling. We agree with the practical result but would offer the following explanation. We have found that at temperatures of the order used by the authors, a fuel oil, once sheared, does not rebuild its structure to the full extent. We therefore attribute the differences in the behavior in large scale runs 3 and 4 mentioned in the paper to destruction of the gel by pumping while cooling (at temperatures of 60 F, 54 F, 45 F, and 44 F in run 3), which did not occur in run 4.

[1] V. L. Shipp and L. D. Tredick, "Laboratory Tests for Pumpability of Residual Fuel Oils," ASTM BULLETIN, No. 189, April, 1953, p. 48 (TP54).

[2] Sunbury Research Station, Anglo-Iranian Oil Co., Ltd., England.

[3] Method of Test for Cloud and Pour Points (D 97 – 47), 1952 Book of ASTM Standards, Part 5, p. 51.

Determination of Non-Evaporable Water in Hardened Portland-Cement Paste

By L. E. Copeland and J. C. Hayes[1]

WHEN dealing with the strength of concrete, it is customary to make comparisons between specimens of the same age. For many purposes this is clearly an adequate procedure. But for other purposes, particularly the study of cement hydration, equal age is not a suitable basis for comparison. It is not suitable because different cements hydrate at different rates, and the same cement hydrates faster when the water-cement ratio is high than when the ratio is low. Therefore, in chemical studies, comparisons at equal age may serve no useful purpose. This is true also of some kinds of physical studies; it may be advantageous to treat the rate of gel formation separately from the intrinsic strength of the gel. Thus, in various studies it is desirable to know how much of the cement in a given sample has become hydrated.

Obtaining this information is complicated by the impossibility of separating water that has reacted chemically from water bound by surface or capillary forces; therefore, the amount of hydrated cement must be deduced from other measurements. The authors have found that the water retained by the sample after it is dried at a very low water vapor pressure is approximately proportional to the weight of the cement which has hydrated, and consequently have used a measure of this "non-evaporable water" to estimate the degree of hydration.

The method of analysis for non-evaporable water in hardened, portland-cement paste has been described in previous papers from this laboratory.[2,3] The precision of this method's results has not proved to be as good as desired, and in some cases extended periods of drying have been found to be necessary before an end point is reached. This paper reports the development of a revised method for the estimation of non-evaporable water. The revised method requires a vacuum desiccator connected to a trap held at the temperature of dry ice (−79 C). The system is evacuated with a mechanical vacuum pump during the drying process. The advantages to this method are that the time to reach an end point usually is shorter, and that the partial pressure of water vapor in the desiccator can be maintained constant with greater ease since the tedious control of the composition of the desiccant is unnecessary. As a result, the precision of the revised method is slightly greater than that of the old.

In addition, there is evidence that the non-evaporable water as determined by the revised method is more nearly equal to the chemically combined water.

The earlier method for determining non-evaporable water requires a vacuum desiccator containing a mixture of magnesium perchlorate dihydrate and magnesium perchlorate tetrahydrate as a desiccant. The system is evacuated at the beginning of the drying period and then sealed during the drying process.

A difference between the water contents of the pastes dried by the two different procedures results from slightly different equilibrium pressures of water vapor over the desiccants. The relationship between the values of non-evaporable water as determined by the two methods is presented in this paper.

In discussing the two different procedures, it is necessary to differentiate between the results by the use of appropriate symbols. The vapor pressure of water over the magnesium perchlorate hydrates used is approximately 8 μ of mercury. The vapor pressure of water over ice at −79 C is approximately 0.5 μ. To differentiate between the two methods, $(w_n/c)_8$ is written for the result obtained by drying over magnesium perchlorate dihydrate and $(w_n/c)_{0.5}$ is written for that obtained by drying over ice at the temperature of dry ice.

The Revised Method of Analysis

A diagrammatic sketch of the apparatus is given in Fig. 1. The apparatus consists essentially of a vacuum desiccator connected to the side arm of a trap by large-bore glass tubing. The small mercury-sealed vacuum stopcock sealed into the side arm is used to break the vacuum when samples are to be removed from the desiccator. The trap is held at −79 C by means of dry ice and alcohol. A layer of corrugated cardboard around the trap extends about 8 in. below the side arm. This cardboard is completely covered with rubber tape and serves as an insulating wall between the trap and the dry ice in the Dewar jar in the region of the dry ice - air boundary. The trap is connected to a mechanical vacuum pump which will hold the pressure in the system below 30 μ.

The samples to be analyzed are crushed in a mortar or on a specially designed anvil. The fraction of material passing a No. 30 and retained on a No. 80 screen is used for the analysis.

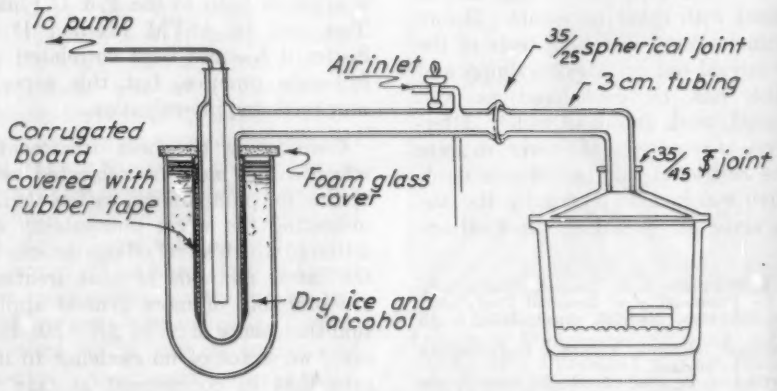

Fig. 1—Diagram of Apparatus.

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[1] Senior Research Chemist, Portland Cement Assn., Chicago, Ill., and Research Chemist, Zonolite Corporation, Evanston, Ill., respectively.

[2] T. C. Powers and T. L. Brownyard, "Studies of the Physical Properties of Hardened Portland Cement Paste," *Proceedings*, Am. Concrete Inst., Vol. 43, pp. 257–263. (1947). PCA Bulletin 22.

[3] T. C. Powers, "The Nonevaporable Water Content of Hardened Portland-Cement Paste—Its Significance for Concrete Research and Its Method of Determination," ASTM BULLETIN, No. 158, May, 1949, p. 68 (TP94).

Five to six grams of crushed material is spread in a thin layer on the bottom of a weighing dish about 5 cm in diameter. These operations are performed in a closed cabinet containing CO_2-free air. The dishes are quickly transferred to the desiccator, the apparatus is assembled, and the pump is started, the trap having been previously cooled with a mixture of dry ice and alcohol.

After 5 to 7 days of drying, the samples are removed from the vacuum system and weighed. To break the vacuum, dry, carbon-dioxide-free air is introduced through the stopcock sealed into the side arm of the trap. This stopcock is placed between the desiccator and the trap to prevent the air from passing through the trap into the desiccator and carrying small crystals of ice along with it.

The drying is continued until weighings on successive days indicate that the rate of weight loss is no larger than 1 mg of water per gram of paste for one day of drying.

After the end point is reached, the weighed sample is ignited at 1050 C in a platinum crucible for about 30 min, then weighed and replaced in a furnace for a second ignition period of 10 min and reweighed. Usually these two ignited weights will check satisfactorily, but if they do not, a third ignition is necessary.

The weight loss on ignition is due to the volatilization of the non-evaporable water and volatile material present in the original cement.

The non-evaporable water is usually expressed in grams of water per gram of original cement and considered to be equal to the increase in ignition loss beyond that of the original cement. It is the difference between the ignition loss of the paste and the ignition loss of the original cement, both expressed in grams of water per gram of original cement. The ignition loss of the original cement must be determined by a separate experiment.

The following equation (derived by Powers may be used:

$$\frac{w_n}{c} = \frac{W_1}{W_2}(1 - L) - 1$$

where:

- w_n/c = non-evaporable water content, grams non-evaporable water per gram of original cement,
- W_1 = weight of paste prior to ignition, grams,
- W_2 = ignited weight of paste, grams, and
- L = ignition loss of original cement, grams per gram of original cement.

Discussion of Experimental Conditions

In some cases if the pump reduces the pressure too rapidly, moisture vapor escapes from the sample fast enough to carry small particles out of the weighing dish. Hence, the initial evacuation must be watched closely and, if such blowing starts, the stopcock between the vacuum pump and the trap must be closed immediately. After the system has stood for an hour under these conditions, the stopcock may be reopened and pumping continued until blowing starts again. Repeating this procedure two or three times usually will be sufficient to eliminate blowing.

On some occasions the authors have analyzed fresh pastes or hardened pastes containing large amounts of evaporable water. These specimens were sealed in airtight metal cans and then frozen in a dry ice-alcohol bath. The frozen samples were transferred quickly to the vacuum desiccator; the desiccator was then quickly evacuated. No trouble with blowing occurred with this technique.

The Drying Period:

The rate of drying is affected greatly by the pressure in the system. If the pressure is maintained below 20 μ, a four-day drying period is sufficient. If the pressure stays around 30 μ, 6 or 7 days are required. If the pressure is as high as 0.1 mm of mercury, the drying is very slow.

Before the insulation was placed around the upper part of the trap, variations in the dry-ice level in the Dewar jar seemed to cause variations in results. If the diffusion of water from the top of the trap to the coldest zone at the bottom of the trap takes place slowly, the partial pressure of water in the system would be controlled by the temperature of the ice near the top of the trap instead of the temperature of ice in the coldest region. On the basis of this hypothesis, the upper part of the trap was insulated from the bath. Under these conditions the water vapor froze out in the bottom half of the trap, several inches below the dry ice-air boundary level. There was no variation in results when the level of dry ice was maintained above the lower boundary of the insulated region.

A question arose as to whether, in this continuous pumping procedure, the speed of the pump was sufficient to reduce the partial pressure of water vapor below the equilibrium pressure of ice at −79 C. A comparison of the results of non-evaporable water determinations upon samples of the same pastes showed that continuous pumping gave the same results as intermittent pumping. The authors use the continuous pumping procedure, as it is simpler to maintain a uniformly low pressure in this manner.

The End Point:

To determine the quantity of water held by a hardened paste which is in equilibrium with ice at −79 C would be

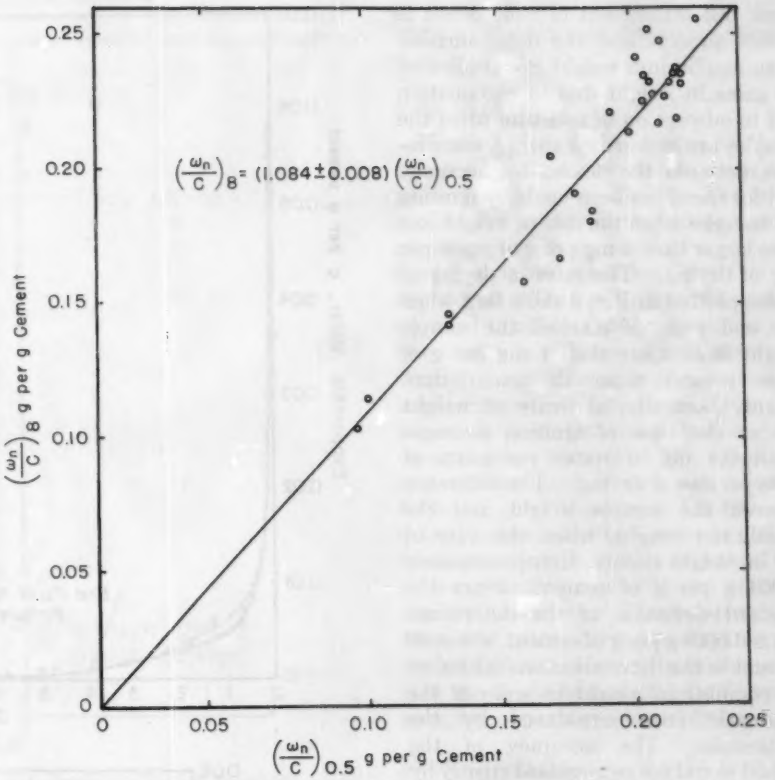

Fig. 2—Drying Curves for Both Methods.

ideal, but attainment of equilibrium is a slow process and the determination of an equilibrium weight is complicated by gains in weight due to carbonation and to adsorption of moisture when the samples are exposed to air. A compromise between the desires for accuracy and for speed has been made by igniting the samples when the rate of weight loss is no larger than 1 mg per g of paste per day of drying. The rates of drying of pastes plotted in Fig. 2 show that when this end point is reached the sample weight is no more than 1 mg per g of paste greater than the equilibrium weight. Actually, the rate of weight loss at the time of ignition averages about 0.4 mg of water per gram of paste per day of drying. The difference between the sample weight and the equilibrium weight, when this rate of loss in weight occurs, is approximately 0.0004 g per g of cement. Since the standard deviation of the determination is 0.0008 g per g of cement, about 30 per cent of the determinations fall below the equilibrium weight in spite of the systematic error introduced by the compromise. The accuracy of the method would not be increased greatly by taking the extra time to determine the equilibrium weight.

Comparison of the Results of the Two Methods

Relationships Between Parameters Representing Physical Properties:

The relationships between the parameters representing various physical properties of a hardened portland-cement paste and the non-evaporable water content will be changed by a change in the method of analysis for the non-evaporable water. For example, the value of V_m, the parameter in the Brunauer, Emmett, Teller adsorption equation[4] identified with the amount of water necessary to form an adsorbed layer one molecule thick, is affected by this change. The new V_m values are approximately 20 per cent higher, but there is no simple relationship between the new and the old values of V_m. The same statement will be true for other parameters related to V_m.

On the other hand, some parameters are related in a simple manner to the amount of non-evaporable water. The relationship between these parameters and $(w_n/c)_s$ can be stated in terms of the corresponding relationships with $(w_n/c)_{0.5}$ by a conversion factor.

Conversion Factor:

Figure 3 is a plot of the relationship between the non-evaporable water contents of pastes as determined by the previously used method and the newer method of analysis. These pastes were prepared from Type I cement. Each point plotted is the average of at least two determinations by each method. The position of the line was determined by the method of least squares. The equation of the line is

$$(w_n/c)_s = (1.084 \pm 0.008)\,(w_n/c)_{0.5}$$

Since the coefficient 1.084 was not at first established as precisely as was desired, elaborate precautions were taken in additional determinations to obtain a better value. Samples of paste were suspended from silica springs contained in an evacuated glass jacket (Fig. 4). In this apparatus the drying losses were measured without exposing the samples to the atmosphere until equilibrium weight was reached. In one set of determinations magnesium perchlorate dihydrate was placed in the bottom of the jacket. In another set, a Dewar flask containing dry ice and alcohol was brought up around the bottom of the jacket.

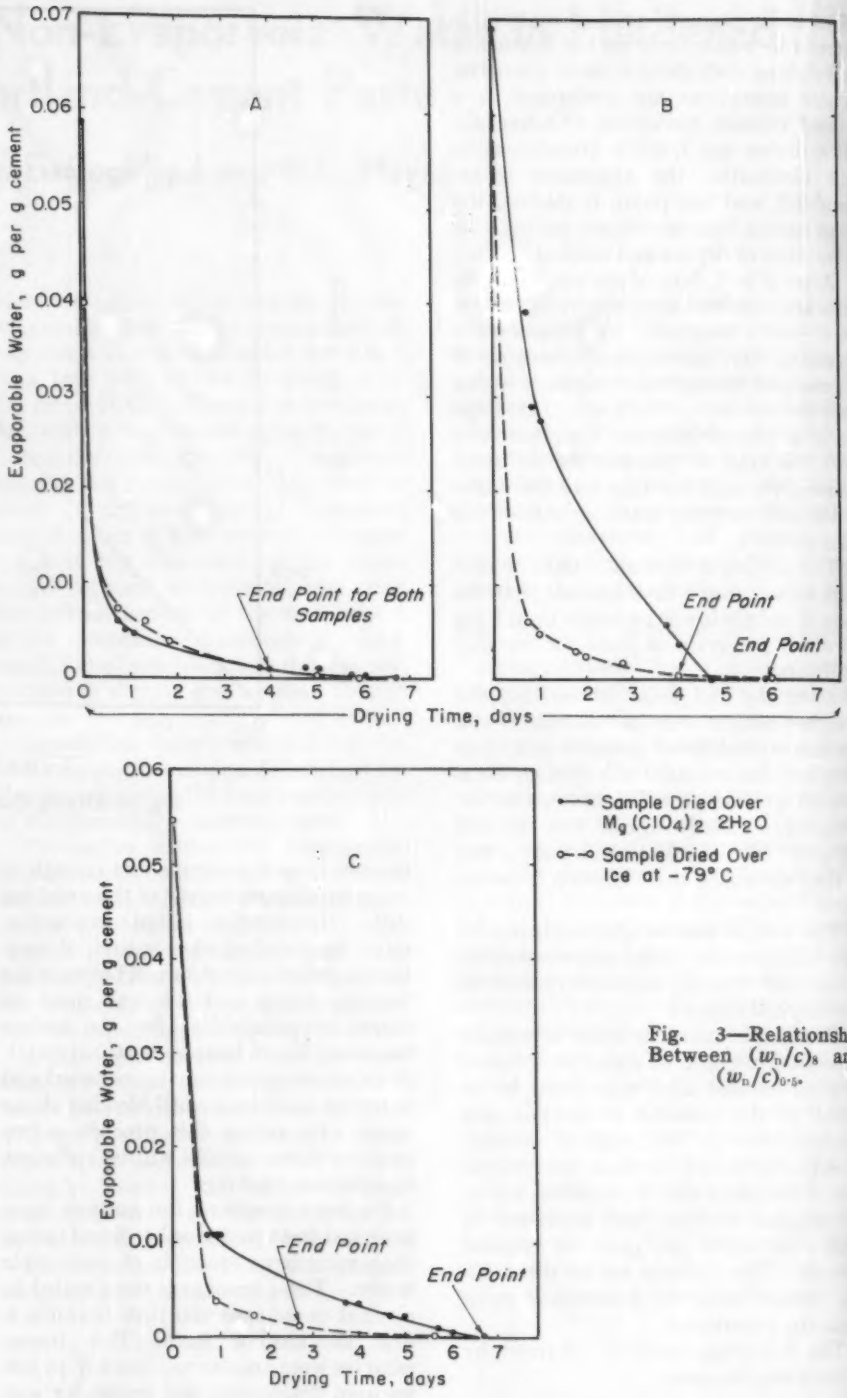

Fig. 3—Relationship Between $(w_n/c)_s$ and $(w_n/c)_{0.5}$.

[4] S. Brunauer, P. H. Emmett, and E. Teller, "Adsorption of Gases in Multimolecular Layers," *Journal*, Am. Chemical Soc., Vol. 60, p. 309 (1938)

The results obtained were no more precise than the results obtained by the regular procedure. It thus seemed that the variation in the results from the regular procedures might have been due to either or both of two factors: first, the temperature in the dry ice - alcohol bath was not sufficiently uniform; second, the vapor pressure of water over magnesium perchlorate hydrate in the range of compositions selected was not constant. These factors were investigated individually.

Partial Pressure of Water over Hydrates of Magnesium Perchlorate:

No measurements of the vapor pressure of water over the various hydrates of magnesium perchlorate have been reported in the literature. An attempt was made to obtain this information by placing magnesium perchlorate in the apparatus (Fig. 4) and determining the changes in composition as the vapor pressure of water in the system was varied. It was established that the vapor pressure of water over magnesium perchlorate hydrates is 8.2 ± 0.5 μ over a range of mole ratios of water to magnesium perchlorate, from about 2 to 4. The time required to reach the equilibrium vapor pressure after the addition of water vapor to the system depended to some extent upon the composition of the magnesium perchlorate hydrate. The shortest time observed for reaching equilibrium after minute additions of water vapor was three days. Periods of ten days to two weeks were required when the composition of the hydrate was near to either 2 or 4 moles of water per mole of magnesium perchlorate. This low rate of approach to equilibrium makes it difficult not only to obtain a precise measurement of the equilibrium vapor pressure but also to achieve reproducible drying conditions for the removal of evaporable water from hardened pastes.

Fluctuations of Water Vapor Pressure in the Cold Trap:

Any condition which produces variation in the partial pressure of CO_2 in the Dewar jar containing the trap would produce variations in temperature within the trap. Such temperature variations would cause fluctuations of the partial pressure of water vapor in the drying system. The magnitude of these changes was investigated in two experiments which included periods of 64 hr when no dry ice was added to the Dewar jar.

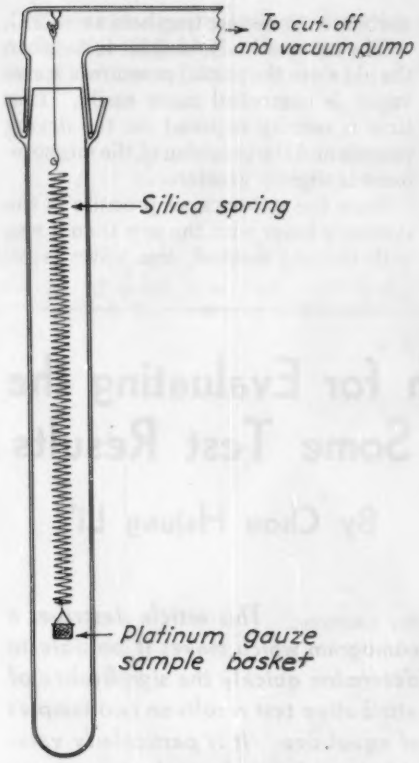

Fig. 4—Silica Spring Balance

The temperature near the bottom of the trap was found to be −79.2 C. The range in temperature observed, 2 C, would cause a change in the partial pressure of water of 0.15 μ Hg.

As shown in Fig. 3, a change in pressure from 0.5 μ to 8.0 μ corresponds to a change in the non-evaporable water of 8.4 per cent. It is thus probable that fluctuations of the order of 0.15 μ would cause errors of only a few tenths of one per cent.

Precision of the Non-evaporable Water Determination:

Several analysts aided in making the comparative determinations. The results obtained by the different analysts with a given method were equally precise. The standard deviation from replicate determinations using the dry-ice procedure is 0.0008 g per g of cement as compared with 0.0012 for the magnesium perchlorate - dihydrate procedure.

Rates of Drying:

Figure 2 gives drying curves for three samples by the two methods, using the apparatus shown in Fig. 4. The pressure in the jackets during these experiments was approximately 25 μ. Under most favorable conditions there is no significant difference between the times required to achieve the end point in the two methods. These conditions—primarily, the maintenance of a uniformly low pressure—are more easily maintained in a system subjected to continuous evacuation than they are in a system evacuated, closed, and allowed to stand. For this reason the time required to reach the end point in the revised procedure is usually less than the time required to reach the end point in the old procedure. These curves also show that after about four days drying the rate of loss of water from the paste is in the neighborhood of 1 mg of water per gram of paste per day of drying.

Relationship Between Results from the Two Methods for Different Cements:

The amount of non-evaporable water held by a paste at a given degree of hydration is determined by the chemical composition of the cement from which the paste is made as well as by the particular desiccant used for drying the sample. However, it has been shown previously[5] that the amount of non-evaporable water held over one drying agent relative to the amount held over another was independent of the composition of the cement from which the paste was prepared. More evidence has been obtained in the present studies in which the non-evaporable water was determined on a series of pastes by both methods. The results, tabulated in Table I, show again that, with the possible exceptions of cements Nos. 4, 5, and 6 the composition of the cement has no statistically significant effect upon the ratio of $(w_n/c)_s$ to $(w_n/c)_{0.5}$

[5] T. C. Powers and T. L. Brownyard, "Studies of the Physical Properties of Hardened Portland Cement Paste," *Proceedings*, Am. Concrete Inst., Vol. 43, p. 258 (1947).

TABLE I.—RATIOS OF $(w_n/c)_s$ TO $(w_n/c)_{0.5}$ FOR DIFFERENT PORTLAND CEMENTS.

	Chemical Analysis of Cement Used to Prepare These Pastes (Oxide Analysis)													$\frac{(w_n/c)_s}{(w_n/c)_{0.5}}$	Number of Determinations
	SiO_2	Al_2O_3	Fe_2O_3	Total CaO	MgO	SO_3	Loss on Ign.	Insol. Res.	Free CaO	FeO	TiO_2	Na_2O	K_2O		
Cement No. 1....	20.85	6.44	2.20	63.96	2.50	2.36	0.95	0.19	0.93	0.60	0.28	0.17	0.16	1.084	40
Cement No. 2....	22.50	4.39	4.14	64.31	1.46	1.73	1.39	0.13	0.49	nil	0.30	0.05	0.17	1.095	2
Cement No. 3....	19.98	5.50	2.55	66.57	1.25	1.84	1.56	0.17	3.14	0.03	0.26	0.30	0.40	1.080	1
Cement No. 4....	27.52	2.09	1.96	63.93	1.70	1.88	0.74	0.07	0.15	nil	0.11	0.05	0.22	1.111	2
Cement No. 5[a]...	23.0	4.9	5.0	59.6	3.0	2.0	1.35	0.10	0.4	trace	0.23	0.06	1.19	1.107	1
Cement No. 6[a]...	26.4	3.0	2.7	63.1	1.8	1.5	1.09	0.16	0.2	trace	0.16	0.16	0.26	1.133	1

[a] Chemical analyses for these cements not corrected for minor constituents.

even though there is some theoretical basis for predicting an effect.

Summary and Conclusions

A revised method for determining the non-evaporable water of hardened portland cement pastes has been described. This method consists in drying samples in an evacuated space which is connected to a moisture trap held at −79 C.

The new method is simpler to use than the old since the partial pressure of water vapor is controlled more easily. Less time is usually required for the drying process and the precision of the measurement is slightly greater.

Since the water vapor pressure in the system is lower with the new than it was with the old method, less water is retained by the sample. This change in the quantity of non-evaporable water requires the use of a conversion factor if analyses by the new method are to be compared with analyses by the old method. The non-evaporable water determined by the old method may be approximated by multiplying the non-evaporable water obtained by the new method by 1.084.

A Nomograph for Evaluating the Significance of Some Test Results

By Chou Hsiung Li[1]

This article describes a nomogram which makes it possible to determine quickly the significance of attributive test results on two samples of equal size. It is particularly valuable to such people as plant managers, purchasing agents, production engineers, quality-control men, and research workers.

WHEN sampling procedures are used in the inspection of two groups of objects, it is often rather difficult to determine whether observed differences in the test results are significant or merely due to chance. This difficulty may lead to unjustified suspicion of the data, resulting in indecision and unneeded tests or lack of action, or may cause adoption of conclusions that prove to be false on subsequent tests. Either of these results, which can often be very costly, may be avoided by the proper use of this nomograph.

When a test has shown qualitatively that one process, product, or material is better than another in a certain respect, the use of this nomograph may make it possible to determine quantitatively how reliable such test results are. Without this information, it is impossible to make systematic comparisons of the two processes, products, or materials, weighing together such other factors as economic considerations, engineering difficulties, and the like.

The Meaning of "Significance"

"Significance" is a relative term; what is significant in one instance or to one person may be less significant, or completely insignificant, at other times or to other people. For the sake of clarity, therefore, it is desirable to specify the level of significance used in judging test results. In the nomograph presented here (Fig. 1), the terms "probably significant," "significant," "very significant," and "very, very significant" are used to designate differences between test results for which the probabilities of occurrence due to chance alone are less than one time in ten, twenty, one hundred, or one thousand trials, respectively (1,2).[2] Conclusions that the difference is significant as obtained with the use of this nomograph would, therefore, be wrong only less than one time in ten, twenty, one hundred, or one thousand cases, respectively, in which there is actually no true difference.

Construction of the Nomograph

When two samples, A and B, of equal size, have been inspected, the significance of the difference in the number of defectives in the two samples, d_A and d_B may be determined by means of the following equation:

$$v = \frac{d_A - d_B}{\sqrt{(d_A + d_B)\left(1 - \frac{d_A + d_B}{2n}\right)}} \quad \ldots(1)$$

In this equation, n is the size of the samples and v is the approximately normally distributed variable the value of which would exceed 1.28, 1.64, 2.33, or 3.09 less than one time in ten, twenty, one hundred, or one thousand times, respectively, due to chance alone (2,3). If the size of the two samples is small, however, the distribution of the variable v deviates from normal when the variable is discrete rather than continuous, and tends to become asymmetrical when the percentage of defectives is very small or very large. In such cases, the significance of the difference may be overestimated if the above equation is used. This equation can be adjusted, however, to approximate exact probability figures more closely by bringing each observed value one-half unit nearer the value which would be expected if there were no long-run differences between the two samples. After correction for continuity, the new equation becomes:

$$v' = \frac{(d_A - d_B) - 1}{\sqrt{(d_A + d_B)\left(1 - \frac{d_A + d_B}{2n}\right)}} \quad (2)$$

for $d_A > d_B$.

It should be pointed out that even the value v' is an approximation, and it fails for very small values of n (eight or less) or very small percentages of defectives (below 1 per cent). In such cases, therefore, special care should be exercised in the use of the nomograph.

If the difference between the number of defectives in the two samples ($d_A - d_B$) is represented by D, and the sum of the defectives ($d_A + d_B$) by S, Eq 2 can be rewritten as:

$$2nS - S^2 - \frac{2n(D-1)^2}{(v')^2} = 0 \quad \ldots(3)$$

Equation 3 can then be put into determinant form, as follows:

$$\begin{vmatrix} \frac{(D-1)^2}{(v')^2} & 0 & 1 \\ S & S^2 & 1 \\ 1 & 2n & 0 \end{vmatrix} = \begin{vmatrix} \frac{(D-1)^2}{(v')^2} & 0 & 1 \\ S & S^2 & S^2+1 \\ 1 & 2n & 2n \end{vmatrix} = \begin{vmatrix} \frac{(D-1)^2}{(v')^2} & 0 & 1 \\ \frac{S}{S^2+1} & \frac{S^2}{S^2+1} & 1 \\ \frac{1}{2n} & 1 & 1 \end{vmatrix} = 0 \quad \ldots(4)$$

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

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[1] Metallurgist, Tube Department, Radio Corporation of America, Harrison, N. J.

If it is desired to plot a nomograph r inches long and q inches wide, with D varying from d_1 to d_2 and n from n_1 to n_2, the skew determinant (4) is written by multiplying the determinant on the right (Eq 4) by a nonzero determinant, as follows:

$$\begin{vmatrix} \frac{(D-1)^2}{(v')^2} & 0 & \frac{1}{2} \\ S & S^2 & 1 \\ 1 & 2n & 0 \end{vmatrix} \times \begin{vmatrix} e & f & g \\ h & i & j \\ k & m & t \end{vmatrix} = \begin{vmatrix} \frac{e(D-1)^2}{(v')^2} + k & \frac{f(D-1)^2}{(v')^2} + m & \frac{g(D-1)^2}{(v')^2} + t \\ eS + hS^2 + k & fS + iS^2 + m & gS + jS^2 + t \\ e + 2hn & f + 2in & g + 2jn \end{vmatrix} = 0$$

It is desirable, however, for the Y-axis to serve as a basis for the D-scale in the nomograph. Therefore, the term $\frac{e(D-1)^2}{(v')^2} + k$ must equal zero, and the term $\frac{g(D-1)^2}{(v')^2} + t$ must not be equal to zero. These conditions are met if $e = k = g = 0$ and $t = 1$. The skew determinant then becomes:

$$\begin{vmatrix} 0 & \frac{f(D-1)^2}{(v')^2} + m & 1 \\ hS^2 & fS + iS^2 + m & jS^2 + 1 \\ 2hn & f + 2in & 2jn \end{vmatrix} = 0$$

or

$$\begin{vmatrix} 0 & \frac{f(D-1)^2}{(v')^2} + m & 1 \\ \frac{hS^2}{jS^2+1} & \frac{fS + iS^2 + m}{jS^2 + 1} & 1 \\ \frac{2hn}{2jn} & \frac{f + 2in}{2jn} & 1 \end{vmatrix} = 0$$

From this determinant, it can be seen that:

$$f = \frac{r(v')^2}{d_2 - 1^2 - d_1 - 1^2}$$

$$j = \frac{(v')^2(n_2 - n_1)}{2n_1n_2(d_2 - 1^2 - d_1 - 1^2)}$$

$$h = \frac{q(v')^2(n_2 - n_1)}{2n_1n_2(d_2 - 1^2 - d_1 - 1^2)}$$

$$m = \frac{-r(d_1 - 1^2)}{d_2 - 1^2 - d_1 - 1^2}$$

$$i = \frac{-r(v')^2}{2_2n(d_2 - 1^2 - d_1 - 1^2)}$$

Equations for locating points on the nomograph can then be determined:

$$X_D = 0; \quad Y_D = \frac{f(D-1)^2}{(v')^2} + m = \frac{r(D - 1^2 - d_1 - 1^2)}{d_2 - 1^2 - d_1 - 1^2}$$

$$X_n = \frac{2hn}{2jn} = q; \quad Y_n = \frac{f + 2in}{2jn} = \frac{rn_1(n_2 - n)}{n(n_2 - n_1)}$$

$$X_S = \frac{hS^2}{jS^2 + 1} = \frac{q(v')^2S^2(n_2 - n_1)}{(v')^2S^2(n_2 - n_1) + 2n_1n_2(d_2 - 1^2 - d_1 - 1^2)}$$

$$Y_S = \frac{fS + iS^2 + m}{jS^2 + 1} = \frac{rn_1(2n_2(v')^2S - (v')^2S^2 - 2n_2d_1 - 1^2)}{(v')^2S^2(n_2 - n_1) + 2n_1n_2(d_2 - 1^2 - d_1 - 1^2)}$$

In the nomograph illustrated in this paper, the following values were assigned for the variables:

$d_1 = 3$ $\quad n_1 = 8$ $\quad r = 10$ in.
$d_2 = 9$ $\quad n_2 = 100$ $\quad q = 6.5$ in.

$v' = 1.28$ for the S-curve corresponding to probability $P = 0.10$
$v' = 1.64$ for the S-curve corresponding to probability $P = 0.05$
$v' = 2.33$ for the S-curve corresponding to probability $P = 0.01$
$v' = 3.09$ for the S-curve corresponding to probability $P = 0.001$

The limiting values for D and n were selected to make the nomograph one of the most useful and practical and to minimize the nonnormality of the v' distribution due to small sample sizes or very small percentages of defectives.

It can be seen that nomographs based on Eq 1 and 2 would be identical except for a one-unit difference in the D-scale. The nomograph based on Eq 2, as is shown here, is preferred for greater accuracy.

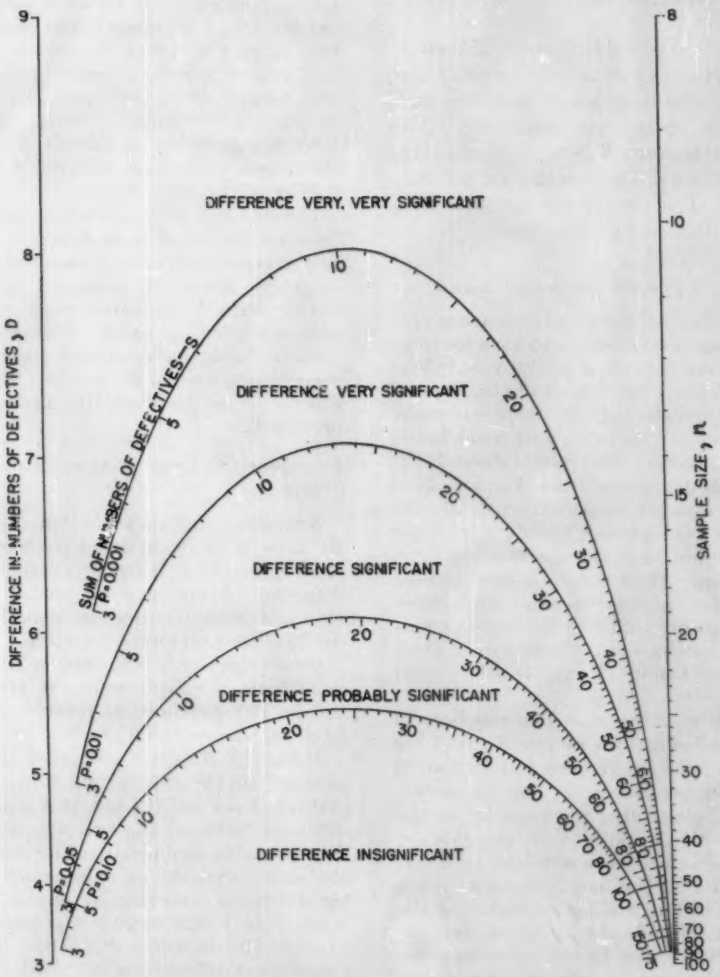

Fig. 1.—Nomograph for Evaluating the Significance of Test Results.

Use of the Nomograph

As mentioned previously, a nomograph of the type shown in this paper may be used to determine the significance of attributive test results only when the two samples to be compared are of equal or very nearly equal size (that is, 50 *versus* 49, or 100 *versus* 97).

In such a case, a straight line is drawn on the nomograph connecting the sample size ($n_1 = n_2$) on the n-scale to the difference between the numbers of defectives ($D = d_2 - d_1$) on the D-scale. The two S-scales are then found so that the sum of the numbers of defectives ($S = d_1 + d_2$) appears just above the straight line on the upper S-scale but just below it on the lower. These two S-scales identify the region of significance. If the $D - n$ line does not cut all the S-scales, the least statement of significance that can be made is given by the first significance region (from the bottom of the chart) through which the line passes.

Since "acceptable" and "defective" are attributes, they may be interchanged in using the nomograph and will yield the same probability statement. This is desirable when $S > n_1 = n_2$, since the left portions of the S-scales are more accurate. The use of the nomograph is best illustrated by examples.

Example A (for the purchasing agent):

Situation.—A certain company has been purchasing semifinished products for processing from Vendor X exclusively. Vendor Y claimed that his semifinished products, although slightly more expensive than those of Vendor X, were much better in performance. Test results showed that of 20 sample units from Vendor X, 4 (or 20 per cent) were defective; of 20 sample units from Vendor Y, only 1 (or 5 per cent) did not meet the specification.

Question.—Does the difference between the numbers of defectives in the two samples constitute sufficient evidence to warrant the purchase of the semifinished products from Vendor Y at slightly higher cost?

Method of Analysis.—The numbers of defectives being 4 for sample X and 1 for sample Y, their difference and sum are 3 and 5, respectively. A line is drawn, therefore, connecting the point 20 on the n-scale with the point 3 on the D-scale. Since the sum of the numbers of defectives, 5, on all the four S-scales is above the straight line, the lowest region or the region of insignificant difference is indicated. Hence, the difference between the two samples is not significant (that is, less significant than the 0.10 level or $p > 0.10$).

Conclusion.—The difference observed in the numbers of defectives in the two samples could have readily occurred due to chance alone. It is concluded, therefore, that the claim of Vendor Y is very doubtful. It seems inadvisable to purchase the semifinished products from Vendor Y unless stronger evidence in his favor can be furnished.

Example B (for the production engineer):

Situation.—A production department was making a certain semifinished product using a certain set of machines, operators, and raw materials, and a particular process X. A new method, process Y, was proposed which involved a slight modification of the operating conditions. Of 30 semifinished units made according to process X, 6 (or 20 per cent) were defective; of 30 semifinished units made according to process Y, only 1 (or 3.3 per cent) did not meet the specification.

Question.—Is the difference between the numbers of defectives in the two samples sufficiently large to justify the conclusion that process Y is distinctly better than the conventional process X?

Method of Analysis.—A line is drawn on the nomograph connecting point 5 (6 minus 1) on the D-scale with point 30 on the n-scale. The sum of the defectives, 7, on the S-scale representing a probability of 1 in 20 ($P = 0.05$), is just above the straight line, whereas the same number, 7, on the S-scale representing $P = 0.10$ is just below the same line. These two S-scales define the region of probably significant difference. Hence, the difference is probably significant (that is, is significant at a level between 0.10 and 0.05 or $0.10 > P > 0.05$).

Conclusion.—The observed difference between the numbers of defectives in the two samples could happen occasionally due to chance alone. If process Y is better than process X, therefore, more evidence will be needed for proof. However, it is quite probable that examination of a larger sample from each of the two lots will show process Y to be distinctly better than process X.

Example C (for the plant manager or quality-control man):

Situation.—An inspector found that of 40 units of a semifinished product processed in period Y, 2 (or 5 per cent) were defective. From a more recent lot of 40 units manufactured in period X, 9 (or 22.5 per cent) were defective.

Question.—Could the sudden increase in number of defectives in the manufacture of the semifinished product be due solely to chance variation?

Method of Analysis.—Because the line joining 7 on the D-scale and 40 on the n-scale does not cut the lowest S-scale, the difference between the two samples is at least probably significant. The same line also shows that the probability of such a big difference occurring by chance alone is less than 1 time in 20 but greater than 1 time in 100 (or $0.05 > P > 0.01$). Hence a significant difference is indicated.

Conclusion.—The significant difference between the numbers of defectives in the two manufacturing periods X and Y shows that the manufacturing process was out of control in period X as compared to period Y. It is necessary, therefore, to seek assignable causes for the lack of control and to adopt corrective measures quickly.

Example D (for the research worker):

Situation.—Several environmental factors affected the performance of a certain product. Of these factors, one particular factor was probably the most influential. Performance tests were conducted to determine the effect of the presence, condition Y, or absence, condition X, of this factor. Of 50 sample units tested under condition X, the performance of 11 (or 22 per cent) was unsatisfactory; of 50 sample units tested under condition Y, only 2 (or 4 per cent) performed unsatisfactorily.

Question.—Are the results of these performance tests sufficient to warrant a conclusion that the particular environmental factor is beneficial to the performance of the product?

Method of Analysis.—Because the line drawn from the point 9 on the D-scale to the point 50 on the n-scale does not intersect the lowest S-scale, the difference between the numbers of defectives in the two samples is at least probably significant. The point 13, the sum of the defectives, on the S-scale representing $P = 0.001$ is just above the straight line, whereas the same point, 13, on the S-scale representing $P = 0.01$ is just below the same line. The difference must, therefore, be considered very significant, but not very, very significant (that is, at a significant level between 0.01 and 0.001, or $0.01 > P > 0.001$).

Conclusion.—The presence of the particular environmental factor is distinctly beneficial to the performance of the product, and it is recommended that this factor be present in all future use of the product

In all four of the examples given, the defectives in the sample X were about 21 per cent, while those in the sample Y were about 4 per cent. Because of the varying sizes of the samples, however, the difference in the number of defectives was insignificant in example A, probably significant in example B, significant in example C, and very significant in example D. These examples illustrate how easily erroneous conclusions may be reached if the use of statistical techniques is neglected. It can also be seen that comparative test results expressed in terms of per cent defectives may be very misleading if the actual size of the sample is not given.

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Asphalt Tile Cleaner Specifications, No. 192, September, p. 59 (TP149).

Reclamation Can Relieve Asbestos Shortage

BECAUSE of its incombustibility, strength, and low conductivity, asbestos is widely used in roofing shingles, fireproof paints, stove and building insulation, heat-resistant aprons and gloves, and brake linings. Present supplies of this raw material are critically short.

Simple, effective procedures for reclaiming asbestos from discarded pipe insulation have been developed at the National Bureau of Standards. During the reclamation, extraneous material is removed from the asbestos cloth by chemical treatment, and the cleaned cloth is reduced to fiber form in a paper-pulp beater. The recovered asbestos is unchanged chemically, with little or no shortening of the fibers. It appears well suited to further use as electrical and heat insulation, for making asbestos paper, and as a filler in molded plastic compounds.

Discarded pipe insulations which can be reclaimed are of three general types: asbestos cloth, asbestos-cotton cloth, and molded pipe lagging having asbestos fiber as a filler and magnesia cement as a binder. Even asbestos-cotton cloth with glass strands woven into the yarns or painted or covered with magnesia cement can be utilized in the process. After removing the extraneous material, the cleaned yarns or cloth can be reduced to fibrous form.

For applications where flexibility is desired, such as asbestos paper or cloth chrysotile asbestos is used. Although this type of asbestos is quite satisfactory for insulating heated pipes, it loses its water of constitution and becomes brittle when heated to about 800 C. It was therefore necessary to develop procedures that would reclaim the asbestos fibers without the use of excessively high temperatures.

Asbestos or asbestos-cotton fabrics other than those containing paint can be freed of adhering cement by first treating with 5 per cent hydrochloric acid and then rinsing. Fabrics painted on one side are treated with alkali instead of acid to remove the paint as well as the cement. This is accomplished by boiling in 5 per cent sodium hydroxide solution for 15 to 30 min, followed by a preliminary rinsing, a warm wash with a synthetic detergent to remove the paint pigments, and a final thorough rinsing.

Removal of cotton from the cleaned cloth is best effected by the use of heat, but the process requires rather careful control to avoid loss of the water of constitution and consequent embrittling. Thin layers of the material are heated in a muffle furnace at a temperature between 400 and 450 C. The time necessary to burn out the cotton in this temperature range depends largely on the equipment used. After removal of cement, paint, and dirt, the cloth is reduced to fiber in a rotary food blender or in a paper pulp beater.

An acid wash followed by rinsing will remove most of the cement from fabric containing glass strands. But removal of the dirt is difficult without loss of some of the short asbestos fibers which float off with the dirt. The recovered product contains glass fibers intermixed with the short asbestos fibers and thus will probably be of limited use.

So far, molded insulation yields only 15 per cent of fiber, highly contaminated with foreign materials. Thus, recovery of asbestos from such material does not seem very practicable. In any case, use of the fibers recovered from the molded insulation will have to be limited to magnesia-cement components and similar products.

A Flex-Tension Machine for Shoe Upper Leather

EXCELLENT flexing endurance has made leather especially suitable for the manufacture of shoes. However, satisfactory methods for measuring this property in leather have been lacking, largely because of the extremely long time required to cause failure of a specimen. Recently the National Bureau of Standards developed a flex-tension machine which accurately evaluates the flex endurance of shoe upper leather within a relatively short time. The work was done in the course of an investigation of the flex life of leather sponsored at the Bureau of the Office of of the Quartermaster General. This leather flexer has proved effective in detecting differences in leathers due to tannage, lubrications, and other treatments. It should thus be of value in the development of improved leathers for shoe uppers.

Air Pollution Abatement Manual

OVER a period of two years the Manufacturing Chemists Assn., Inc. has issued eight chapters of a proposed 13-chapter "Air Pollution Abatement Manual." These various chapters are individually saddle stitched and are punched for convenient use in ring binders. After a brief preface and introduction, the first chapter now available (Chapter 3) discusses at some length Community Relations and the importance of keeping the community informed, particularly clubs, civic organizations, etc. It is interesting to note that there is only one state, Oregon, which has state-wide air pollution enactment to date.

The chapter on Physiological Effects discusses not only those materials having a toxic effect but the nature of offensive odors as well as eye, nose, and throat irritations. This chapter also includes a table of industrial hygiene standards indicating the maximum allowable concentration for a 40-hr week. Fifty-four pages are devoted to a discussion of sampling procedures, measuring equipment, and analytical methods. Chapters 8, 9, and 11 discuss Meteorology of Air Pollution, Dust and Mist Collection, and Evaluation of Data, respectively. The Bibliography Chapter is quite extensive and is broken down into general groups as biography, legislative, technical, standards, education, and miscellaneous. These general groups are further divided into more specific subjects.

Prices of the chapters now available range from 15 to 75 cents and can be obtained from the Association, 246 Woodward Bldg., Washington 5, D. C.

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Symposiums on Materials and Design for Lightweight Construction—the Titanium Seminar

THE Titanium Seminar sponsored by the Materials Branch, Technical Service Department of the Engineers Research and Development Laboratories, is a complete record of the technical papers which were presented at the ERDL Theater on May 11, 1951. The general purpose of these meetings was to initiate an educational program for ERDL personnel and other agencies interested in the latest knowledge available on lightweight materials and design of lightweight equipment. This combined report is designed to provide a reference for those who attended the Seminar and to make available the details and data available in the papers to interested individuals who could not attend the meetings. The 95-page report includes eight papers starting with the history of titanium and carrying on through the present production status, uses of high purity titanium, physical and mechanical properties of commercial titanium, corrosion resistance, shop characteristics, casting and forging, applications, and potential uses.

Copies of the mimeographed report are obtainable from U. S. Department of Commerce, Office of Technical Services, Washington 25, D. C. The price is $2.50.

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Handbook of Chemistry and Physics

A RECENT addition to the reference books in frequent use at ASTM Headquarters is a copy of the 34th Edition of the Handbook of Chemistry and Physics. The utility of this edition is improved over that of previous editions by complete revisions of the tables giving physical constants of inorganic and of organic compounds, and by the addition of various new tables. This 2914-page book contains 300 pages of mathematical tables, 1150 pages of properties and physical constants, 429 pages of general chemical tables, 673 pages of physics data, and 340 pages of quantities and units.

The handbook, durably bound in a colorful red and green simulated leather cover, is available at $8.50 per copy from the Chemical Rubber Publishing Co., 2310 Superior Ave., N. E., Cleveland, Ohio.

• • •

University Patent Policies and Practices

This 229-page book by Archie M. Palmer was prepared on the basis of the extensive surveys of the policies, practices, and procedures of universities, colleges, technological institutes, and professional schools which the Office of Patent Policy Survey of the National Research Council has been conducting. The volume contains an interpretive analysis of the current situation in more than 800 universities, colleges, technological institutes, and professional schools; verbatim statements of formalized patent policies and descriptions of generally accepted institutional practices; procedures for handling contractural research and grants; and patent management; based upon the findings of a comprehensive survey of research and patent management activities at higher educational institutions in the United States and Canada.

Priced at $3, the book can be obtained from Patent Policy Survey, National Research Council, 2101 Constitution Ave., Washington 25, D. C.

Probability Tables for the Analysis of Extreme-Value Data

National Bureau of Standards Applied Mathematics Series 22, ii, 32 pages, 25 cents. Government Printing Office, Washington 25, D. C.

EXTREME-value data arise in a great diversity of fields where extreme phenomena are of special interest, such as studies of strength of materials, aerodynamics, meteorology, geology, and flood control.

The volume includes: four tables relating to the reduced form $[\exp(-e^{-y})]$ (asymptotic) probability distribution of the maximum value in a (large) sample—the largest "extreme"; a table for the n largest extremes; and a table for the asymptotic range.

These tables were prepared at the suggestion of, and in consultation with, Dr. E. J. Gumbel, a pioneer in the theory and analysis of extreme-value data.

• • •

The Bleaching of Pulp

THE tenth monograph of the Technical Association of the Pulp and Paper Industry discusses the essential knowledge relating to the various bleaching processes as applied to the principal grades of wood pulp.

Each chapter is written by an Association member on his particular field. The chapters describe processes, giving historical background, procedures used, preparation of the pulp, chemical reactions involved, charts illustrating rates and process variables, control tests, equipment, and instrumentation.

This 364-page work is a significant contribution to the pulp-bleaching technical literature. It may be obtained from TAPPI, 155 E. 44 St., New York, N. Y.

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Electron Microscopy Bibliography

A BIBLIOGRAPHY on Keysort cards intended to keep abreast of world literature in all fields of electron microscopy is being issued by the New York Society of Electron Microscopists. The first issue of about 700 cards covering the years 1950, 1951, and 1952 is now available. Early publication of material for 1953 and quarterly publications on current literature thereafter are planned.

Further information regarding this bibliography and the special prices in effect to Dec. 31, 1953, can be obtained from the New York Society of Electron Microscopists, 2 E. 63rd St., New York 21, N. Y.

PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column.

NOTE—*These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.*

William Bennett has retired after many years' service as Principal Surveyor for USA and Canada, Lloyd's Register, New York City. He is succeeded as Principal Surveyor for USA by **W. J. Roberts,** who has been named to represent Lloyd's ASTM membership which dates from 1912.

William Blum, former Chief of the Electrodeposition Section, National Bureau of Standards, Washington, D. C., was awarded an Elliott Cresson Medal by the Franklin Institute on October 21. Dr. Blum was honored "in recognition of his long-continued and unusually meritorious work in creating a modern scientific basis for the electrodeposition of metals and for his development of useful processes in that field."

T. A. (Tab) Boyd, ASTM Past-President and long-time member, active in both technical and administrative phases of the Society's work, recently retired as Research Consultant, Research Laboratories Div., General Motors Corp., Detroit, Mich. A member of the original "Ludlow Street Gang," the technicians who made up the first organization preceding creation of GM Research Laboratories, Tab, with Charles F. Kettering (founder of the original group) and the late Thomas Midgley, Jr., discovered tetraethyl lead as an antiknock compound, leading the way to development of high-octane fuels for cars and planes.

Mr. Boyd has had a notable record of activity in the Society, and will continue his interests in some of the work. He was Chairman of Committee D-2 on Petroleum Products and Lubricants for 15 years, and also headed the Detroit District for one term.

Earl B. Candell, of General Electric Co., Lamp Division, Cleveland, Ohio, has been elected President of the Society of Industrial Packaging and Materials Handling Engineers.

Theodore Irving Coe, Technical Secretary, American Institute of Architects, Washington, D. C., and long-time leader in standardization, recently received the signal honor of election as a Fellow of The American Institute of Architects. In ASTM, Mr. Coe has been very active for many years in various technical committees. He also served as the first Secretary of the Washington, D. C., District Council, 1947–1950.

Crucible Steel Co. of America, Pittsburgh, Pa., appointed **David I. Dilworth, Jr.,** Director of Metallurgy, to succeed **Lorin L. Ferrall,** who becomes Assistant Vice-President assigned to the Operating Department of the company.

A. T. Curtin, formerly with the Pittsburgh Testing Laboratory, Miami, Fla., is now Manager, Dade Testing Laboratory, Hialeah, Fla.

John H. Curtiss, until recently Chief, National Applied Mathematics Laboratories, National Bureau of Standards, Washington, D. C., is now on the staff of the Institute for Mathematical Sciences, New York University, New York City, in the capacity of Senior Scientist.

Richard Chesney Elstner has completed research work at the University of Illinois and has accepted a position as Associate Development Engineer, Portland Cement Assn., Chicago, Ill.

Robert F. Field, Engineer (Retired), General Radio Co., Cambridge, Mass., has been elected to honorary membership in ASTM Committee D-9 on Electrical Insulating Materials, in recognition of his major contributions toward the advancement of test methods and specifications developed through the activities of this group.

Harry P. Hagedorn, Engineer of Tests, Purchasing Department, City of Chicago, spoke on "Academic Aspects of Specification Preparation," at the opening fall program meeting of the Chicago chapter of the Construction Specification Institute on October 6.

John L. Ham has been appointed Director, Metallurgical Research Dept., National Research Corp., Cambridge, Mass. Associated with National Research since 1952 as Project Manager in Charge of Physical Metallurgy, Mr. Ham previously was with the Climax Molybdenum Co. Research Laboratories.

L. E. Harper has retired as Chief Chemist, Vanadium Corporation of America. He is succeeded by **Edward S. Brown.**

J. C. Harris, who has been Assistant Research Director of Monsanto Chemical Co.'s Central Research Department in Dayton, Ohio, has been named Director of the newly established Application Research Department at Dayton. The group will be initially interested in the formation of products for the home garden and agricultural chemical fields, as well as products for household use.

George Russell Harrison, Dean of Science at Massachusetts Instiute of Technoiogy, Cambridge, Mass., was awarded an Elliott Cresson Medal by the Franklin Institute "for his valuable work in spectroscopy and for his outstanding improvements in the instruments of spectroscopy."

Wilbur E. Harvey, formerly Chief Metallurgist, John A. Roebling's Sons

(*Continued on page 86*)

Photographed on the occasion of Frank H. Jackson's retirement from the U. S. Bureau of Public Roads, are left to right: J. T. Pauls of the Bureau, Mrs. Jackson, and Mr. Jackson. (For more concerning Mr. Jackson, see page 86.)

Buehler . . .

. . . OFFERS A COMPLETE LINE OF EQUIPMENT FOR THE Metallurgical Laboratory

Buehler specimen preparation equipment is designed especially for the metallurgist, and is built with a high degree of precision and accuracy for the fast production of the finest quality of metallurgical specimens.

1. No. 1315 Press for the rapid moulding of specimen mounts, either bakelite or transparent plastic. Heating element can be raised and cooling blocks swung into position without releasing pressure on the mold.

2. No. 1211 Wet power grinder with 3/4" hp. ball bearing motor totally enclosed. Has two 12" wheels mounted on metal plates for coarse and medium grinding.

3. No. 1000 Cut-off machine is a heavy duty cutter for stock up to 3-1/2". Powered with a 3 hp. totally enclosed motor with cut-off wheel, 12" x 3/32" x 1-1/4".

4. 1505-2AB Low Speed Polisher complete with 8" balanced bronze polishing disc. Mounted to 1/4 hp. ball bearing, two speed motor, with right angle gear reduction for 161 and 246 R.P.M. spindle speeds.

5. No. 1700 New Buehler-Waisman Electro Polisher produces scratch-free specimens in a fraction of the time usually required for polishing. Speed with dependable results is obtained with both ferrous and non-ferrous samples. Simple to operate—does not require an expert technician to produce good specimens.

6. No. 1410 Hand Grinder conveniently arranged for two stage grinding with medium and fine emery paper on twin grinding surfaces. A reserve supply of 150 ft. of abrasive paper is contained in rolls and can be quickly drawn into position for use.

7. No. 1400 Emery paper disc grinder. Four grades of abrasive paper are provided for grinding on the four sides of discs, 8" in diameter. Motor 1/3 hp. with two speeds, 575 and 1150 R.P.M.

8. No. 1015 Cut-off machine for table mounting with separate unit recirculating cooling system No. 1016. Motor 1 hp. with capacity for cutting 1" stock.

THE BUEHLER LINE OF SPECIMEN PREPARATION EQUIPMENT INCLUDES . . . CUT-OFF MACHINES • SPECIMEN MOUNT PRESSES • POWER GRINDERS • EMERY PAPER GRINDERS • HAND GRINDERS • BELT SURFACERS • MECHANICAL AND ELECTRO POLISHERS • POLISHING CLOTHS • POLISHING ABRASIVES

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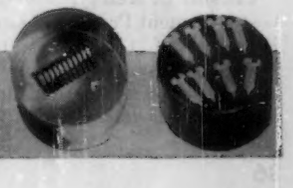

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Corp., Trenton, N. J., is now Director of Engineering and Quality Control, Henry Disston and Sons, Inc., Philadelphia, Pa.

Henry F. Hebley, Research Consultant, Pittsburgh Consolidation Coal Co., Pittsburgh, Pa., was the recipient of the 1953 Percy Nicholls Award, sponsored jointly by the American Society of Mechanical Engineers and the Coal Division of the American Institute of Mining and Metallurgical Engineers, and given in recognition of outstanding achievement in the field of solid fuels. Mr. Hebley's citation honored him particularly for his "recent activities in the control and prevention of both air and stream pollution," his work in these fields being emphasized as "of outstanding value, both to his fellow engineers and to the public at large."

A. J. Herzig, President, Climax Molybdenum Co. of Michigan, Inc., Detroit, was honored at the Centennial Exercises of the University of Michigan late in October when he received one of the "distinguished alumnus" awards from the College of Engineering. Widely known in the metallurgical field, Dr. Herzig has been extremely active in ASTM, perhaps particularly in the Joint Committee on the Effect of Temperature on the Properties of Metals, where he is Chairman of its General Research Panel. He also has been much concerned with the work in the Detroit District, and after a period as Vice-Chairman is now Acting Chairman.

James C. Hicks has been appointed Director of Refractory Research for Kaiser Aluminum and Chemical Corp., Oakland, Calif., to succeed the late Leslie W. Austin. Mr. Hicks will make his headquarters at the Research Laboratory at Milpitas, Calif.

Frank H. Jackson retired from active duty with the U. S. Bureau of Public Roads, Washington, D. C., on September 30, after a period of 48 years, during which he had been engaged in research relating to the materials used in highway construction. Through the years he has participated in the work of many organizations concerned with research and standardization in the highway field, making important and valued contributions. He was active in the Highway Research Board, and in 1948 was presented the Highway Research Board Distinguished Service Award. In 1950 he was presented the Meritorious Service Award of the Department of Commerce. Affiliated with ASTM since 1916, and elected to Honorary Membership in 1948, Mr. Jackson assumed many responsibilities both in administrative and technical phases of the work. A Past-Director of the Society, he is also a Past-Officer of Committees C-1 on Cement, and C-9 on Concrete and Concrete Aggregates, and has served on Committee D-4 on Road and Paving Materials, and other of the technical groups.

Chester C. Kelsey, Manager of the Asbestos-Cement Products Assn., was elected President of the American Trade Association Executives, a professional society of 1500 trade association directors in the United States and Canada.

Edward J. Kenney resigned from York Research Corp., Stamford, Conn., to join the Evaluations Division, Research and Development Department, Colgate-Palmolive-Peet Co.

Edward W. Larson, Jr., formerly Instructor, Civil Engineering Dept., Northwestern University, Evanston, Ill., is now with Hughes Aircraft Co., Los Angeles, Calif.

Kenneth R. Lauer, until recently Testing Engineer with Thompson & Lichtner Co., Brookline, Mass., is now on the faculty of Montana State College, Civil Engineering Department.

Don A. Lawless has accepted a position as Standards Engineer with the Sperry Gyroscope Co., Great Neck, N. Y. He was previously associated with Sam Tour and Co., New York City.

Charles Swain Lumley, formerly Executive Vice-President, H. E. Beyster Corp., Detroit, is now Vice-President, Burns and Roe of Michigan, Inc., in the same city.

Laurence P. Mains, Professor of Civil Engineering at Drexel Institute of Technology, has been named Acting Head of the Department.

Frederick S. Mallette, Research Manager, The American Society of Mechanical Engineers, and Executive Secretary of the ASME Committee on Air Pollution Controls, has been invited to give a Clayton Lecture on Air Pollution before the Institution of Mechanical Engineers of Great Britain in London on April 23, 1954.

Elise McAbee, until recently Testing Supervisor, The Borden Co., Chemical Division, Bainbridge, N. Y., is now at the Picatinny Arsenal, Dover, N. J., in the capacity of Materials Engineer.

Robert F. Mehl, Director, Metals Research Laboratories, and Professor of Metallurgy, Carnegie Institute of Technology, Pittsburgh, Pa., was awarded the Francis J. Clamer Medal of the Franklin Institute, on October 21, "for his contributions to the fields of metallurgy and metallography."

George S. Mikhalapov, formerly Technical Director, Metallurgical Research and Development Co., Washington, D. C., is now Manager, Engineering Development, Knoll Atomic Power Laboratories, General Electric Co., Schenectady, N. Y.

Harry C. Mougey recently retired as Technical Director, Research Laboratories Division, General Motors Corp., Detroit, Mich., after many years of service with the company. One of the original "Ludlow Street Gang," the technicians who made up the first organization preceding creation of GM Research Laboratories, Mr. Mougey pioneered in such essential developments as quick-drying auto finishes, crankcase ventilation, special gear and crankcase lubricants, and plating processes. A Past-Director and longtime member of ASTM, Mr. Mougey has been very active in both administrative and technical phases of the Society's work.

The many friends of **Lawrence A. O'Leary,** Head, Chemical Engineering and Research Dept., W. P. Fuller and Co., South San Francisco, Calif., have been pleased to congratulate him on his wedding some months ago to Mary Eleanor McDevitt. The event took place in Menlo Park, Calif., and among those at the wedding were Mr. and Mrs. Theodore Parker Dresser, Jr., who have been close friends of the bridegroom for many years. A Past-Chairman of the Northern California District, and active in various phases of ASTM work, Larry has done much, both locally and nationally, to promote ASTM activities.

Capt. Elmore S. Pettyjohn, Director of the Gas Institute, Illinois Institute of Technology, Chicago, Ill., received a "distinguished alumnus" award from the University of Michigan's College of Engineering at its Centennial Celebration in October, his citation recognizing him for "his contributions to the development of the field of engineering."

The Rhode Island School of Design, Providence, R. I., celebrated its Seventy-fifth Anniversary in late October by a two-day convocation including an Alumni Association dinner, academic procession, appropriate addresses and exercises, and a special showing of the College's sound and color film, "Design in Your Life." Delegates included representatives of New England Colleges and universities, and educational and professional associations. Governor Dennis J. Roberts and Mayor Walter H. Reynolds brought greetings from State and City.

Fred B. Riggan, for the last three years Vice-President in Charge of Research and Development, Key Co., East St. Louis, Ill., has resigned to establish a foundry consulting service. The author of many technical articles and papers, Mr. Riggan had been associated with the Key Co. since 1938, previously being with National Cast Iron Pipe Co. and Stockham Valve & Fittings, Inc.

George A. Roberts, formerly Chief Metallurgist, has been elected Vice-President in Charge of Technology, Vanadium-Alloys Steel Co., Latrobe, Pa. He now directs the research and development program.

R. Bruce Robinson, until recently with Shipping Containers, Ltd., Ville St. Laurent, P. Q., Canada, is now with the Container Research Lab., Bathurst Power and Paper Co., Montreal.

John H. Schloen was appointed Manager of Canadian Copper Refiners Ltd., Montreal, succeeding H. S. McKnight, who retired some months ago.

W. A. Selvig, for many years Senior Chemist, U. S. Bureau of Mines, Pittsburgh, Pa., is now Chief, Coal Constitution and Miscellaneous Analysis Section, at the Bureau of Mines.

George M. Sinclair, formerly with the Westinghouse Research Labs., Metallurgical and Ceramic Dept., Westinghouse Electric Corp., East Pittsburgh, Pa., is now on the faculty of the University of Illinois, Department of Theoretical and Applied Mechanics.

George Sines, until recently on the faculty of the University of California, Los Angeles, has been named Assistant Professor, Institute for Study of Metals, University of Chicago.

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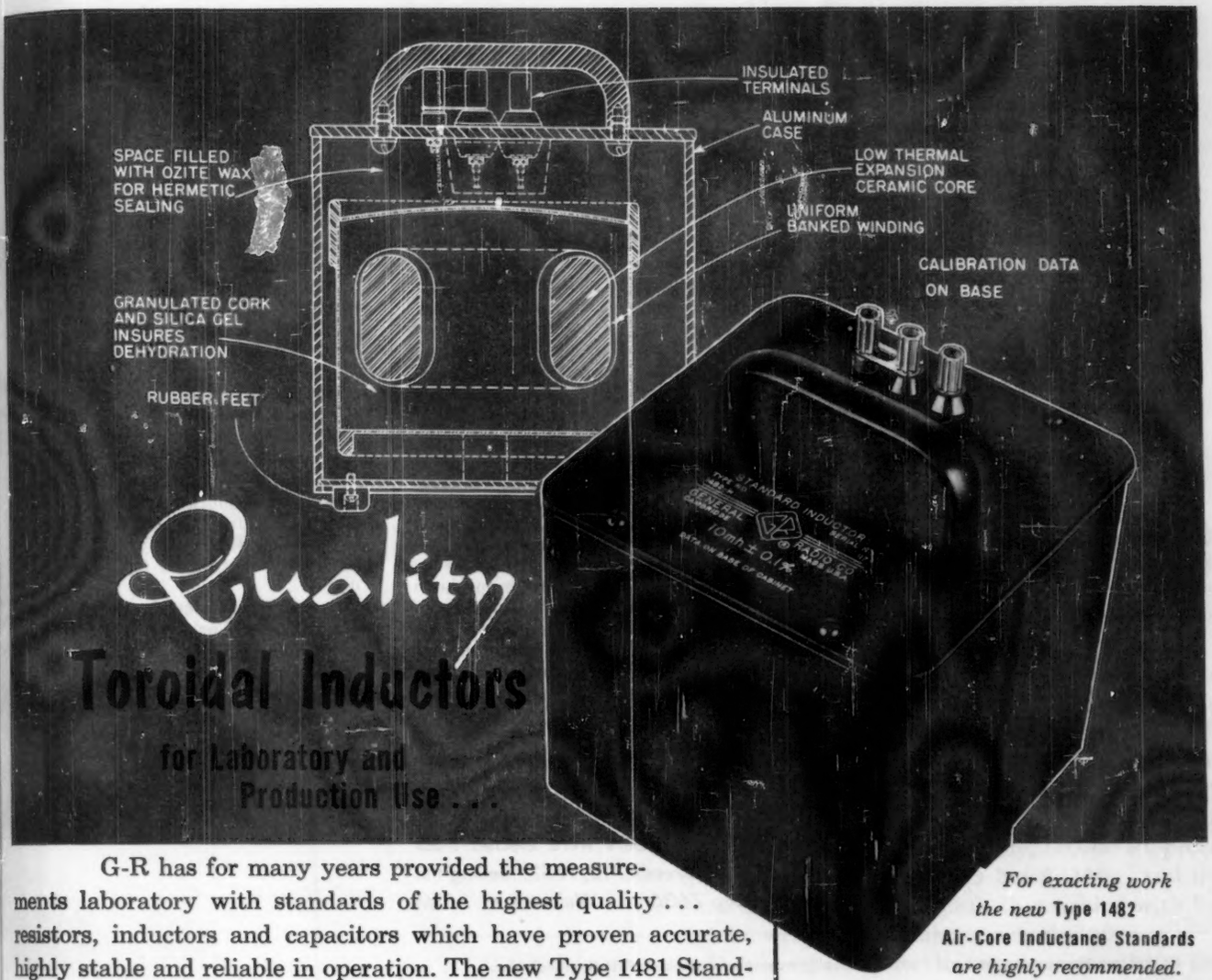

Quality Toroidal Inductors

for Laboratory and Production Use . . .

G-R has for many years provided the measurements laboratory with standards of the highest quality . . . resistors, inductors and capacitors which have proven accurate, highly stable and reliable in operation. The new Type 1481 Standard Inductors with powdered-iron cores and Type 1482 Air-Core Inductors are in keeping with the superior characteristics of past General Radio R-L-C components. They are particularly designed for use at audio frequencies.

These new inductors are symmetrically-wound toroids with negligible coupling to adjacent units and external fields . . . Q's are as high as is practically attainable, the units are electrostatically shielded, they have low and predictable temperature coefficients, and are practically immune to the effects of humid atmosphere.

For exacting work the new **Type 1482 Air-Core Inductance Standards** *are highly recommended.*

Sixteen models available with inductance values ranging from 100 μh to 10 h inclusive in 1, 2 and 5 unit values, **$60 to $185.**

100 μh and 200 μh units adjusted to nominal value of ±0.25%; all units 500 μh and higher adjusted to ±0.1%.

Hermetic sealing and strain-free mounting insures high degree of stability — temperature coefficient of inductance definitely established at 30 parts per million per degree C — accurate temperature corrections can be simply made from resistance measurements.

Calibration certificate on each unit gives inductance to within 0.005% at 100 cycles and indicated stabilized temperature — resonant frequency, d-c resistance, and incremental inductance changes with frequency tabulated on each unit.

Dimensions are 6½" x 6½" x 8" — weight is 11½ lbs.

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Type 1481 Toroidal Dust-Core Inductors complement the air-core Type 1482's, each type having advantages for specific applications.

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(*Continued from page 86*)

G. M. Snyder has accepted a position with the Lovell Manufacturing Co., Erie, Pa. Formerly he had been with the Woodings Verona Tool Works, Verona, Pa.

L. W. Teller, long-time member of the Society and present Chairman of ASTM Committee C-9 on Concrete and Concrete Aggregates, received the Norman Medal at the Annual Convention of the American Society of Civil Engineers in New York in October. The award was made to Mr. Teller and to the late Dr. Friedrich Bleich as co-authors of a paper "Structural Damping in Suspension Bridges." Mr. Teller is Chief, Structural Research Section, Physical Research Branch, Bureau of Public Roads, Washington, D. C.

A. C. Weigel has retired as Vice-President, Combustion Engineering, Inc., New York City. Mr. Weigel had represented his company for many years in the Society and on Committee A-1 on Steel and various of its subcommittees.

Wylie B. Wendt, long-time member of the Society, and for many years on the faculty of the Department of Civil Engineering, University of Louisville, Louisville, Ky., has retired, though he keeps busy on a part-time basis at the Speed Scientific School of the University, and has been made Professor Emeritus of Civil Engineering.

Albert Easton White has retired as Director of the Engineering Research Institute, University of Michigan, and has established offices as Consulting Metallurgical Engineer at 2110 Dorset Road, Ann Arbor, Mich. Dr. White had served for 33 years as Director of the Institute (until 1948 called the Department of Engineering Research). The "ERI News" of a few months ago devoted the entire issue to a review of Dr. White's accomplishments, and his intensive efforts and outstanding contributions to research, noting that "he, more than anyone else, must be credited for building up" this research institution. An affiliate of ASTM since 1909, and a Past-President of the Society, Dr. White has rendered valued service in both administrative and technical phases of the work. In Committee A-1 on Steel, where he was for many years Chairman of Subcommittee XXII on Valves, Fittings, Pipings, and Flanges for High-Temperature and Subatmospheric Temperatures, he has been elected to honorary membership. An active worker in the Detroit District Council, he recently has been made an honorary member of that group also.

John L. Wilson was elected to the Board of Directors of Economics Laboratory, Inc. (SOILAX), St. Paul, Minn., at the annual stockholders meeting in November. With Economics since 1931 as Director of the Research and Development Division, Dr. Wilson directs a large technical staff, and his laboratory has developed many successful detergent and disinfectant products, as well as detergent dispensing devices and electronic controls for washing operation.

John K. Wise, Assistant Director of Research, U. S. Gypsum Co., was elected Chairman of the Paint, Plastics and Printing Ink Division of the American Chemical Society, at the recent 124th ACS Meeting in Chicago.

Arthur C. Withrow Co., of Los Angeles, Calif., developers of specialty lubricants, announce the appointment of Howard L. Farrow as Plant Manager. Mr. Farrow had served as Lubricants Research Supervisor for Richfield Oil Corp. for the past ten years, and previously had been with the Phillips Petroleum Co., Bartlesville, Okla.

George W. Yearley, formerly Manager of the Geneva Works of the True Temper Corp., Cleveland, Ohio, has been named Director of Research and Development of his company.

NEW MEMBERS...

The following 53 members were elected from September 24 to November 12, 1953, making the total membership 7606 . . . Welcome to ASTM

Note—Names are arranged alphabetically—company members first than individuals

CHICAGO DISTRICT

Calumet & Hecla, Inc., Ray Marcotte, Manager, Quality Control, Lock Box 231 Calumet, Mich.

Shaw, Fred B., Jr., Director of Research, Conolite Dept., Continental Can Co., 4300 N. Port Washington Rd., Milwaukee 11, Wis.

CLEVELAND DISTRICT

Dunn, James W., Vice-President, Ohio Adhesives Corp., Box 466, New Philadelphia, Ohio.

Stoffer, K. G., Senior Chemist, Babcock & Wilcox Co., Research Center, Harrisburg and Sawburg Rds., Alliance, Ohio.

DETROIT DISTRICT

Brooks, Joe L., Director of Metallurgy, Muskegon Piston Ring Co., Sparta, Mich.

Casey, Harry E., General Sales Manager, Calsi-crete Corp., 321 N. Hamilton, Saginaw, Mich. For mail: 2624 Scottwood, Toledo 10, Ohio.

Child, James L., Jr., The Hancock Brick and Tile Co., Findlay, Ohio.

Francis, C. V., Research Section Head, Wyandotte Chemicals Corp., Wyandotte, Mich.

Shane, Robert S., Research Project, Supervisor, Wyandotte Chemicals Corp., Wyandotte, Mich.

Williamson, John, President, J-W Materials, Inc., Box 288, Napoleon, Ohio.

NEW ENGLAND DISTRICT

Sigma Instruments, Inc., L. B. Stein, Jr., 170 Pearl St., South Braintree 85, Mass.

NEW YORK DISTRICT

Bongard, W. J., Vice-President, Robert W. Hunt Co., 59 Murray St., New York 7, N. Y.

Coutris, Achilles W., Instructor in Civil Engineering, Yale University, New Haven, Conn. For mail: 15 Prospect St., New Haven, Conn. [J]*

Geering, Rudolph C., Director of Research, Princeton Knitting Mills, Inc., Echo Lake Rd., Watertown, Conn.

Goldberg, J. B., Chemical Engineer, Suite 1336-7, 11 W. 42nd St., New York 36, N. Y.

Klein, A. M., Assistant District Manager, Robert W. Hunt Co., 59 Murray St., New York 7, N. Y.

Raymond, Leonard, Assistant Chief Automotive Engineer, Socony-Vacuum Oil Co., Inc., 26 Broadway, New York, N. Y.

Rugge, G. J., Manager, Moody Engineering Co., 140 Cedar St., New York 6, N. Y.

Summers, Richard, Technical Director, The Quality Control Co., 424 Golden Hill St., Bridgeport 4, Conn.

NORTHERN CALIFORNIA DISTRICT

Raphael, Jerome M., Associate Professor of Civil Engineering, University of California, 307 Engineering Materials Lab., Berkeley 4, Calif.

OHIO VALLEY DISTRICT

Stearns & Foster Co., The, Richard Slaughter, Production Engineer, Wyoming and E. Forrer, Lockland, Cincinnati 15, Ohio.

PHILADELPHIA DISTRICT

Holmes and Son, Archibald, Jerome A. Koerber, Test Engineer, Erie Ave. and K St., Philadelphia 24, Pa.

du Pont de Nemours and Co., Inc., E. I., Polychemicals Dept., Research Div., Alfred C. Webber, Research Supervisor, Experimental Station, Wilmington 98, Del.

Grinsfelder, Henry, Laboratory Head, Rohm and Haas Co., 500 Richmond St., Philadelphia 37, Pa. For mail: 8250 New Second St., Elkins Park 17, Pa.

Harrison, Jerome G., Head, Specifications Dept., The Ballinger Co., 121 N. Broad St., Philadelphia 7, Pa.

Meyer, Harold N., Assistant Metallurgical Engineer, Bethlehem Steel Co., Bethlehem, Pa. For mail: 1825 Jennings St., Bethlehem, Pa.

Moynihan, John T., Chemist, Underwood Corp., 415 St. Marys St., Burlington, N. J.

Pollock, Daniel D., Research Metallurgist, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia 44, Pa. For mail: 561 Haverford Rd., Wynnewood, Pa.

Rose, Arnold S., Supervisor, Research and Development Lab., I-T-E Circuit Breaker Co., 601 E. Erie Ave., Philadelphia 34, Pa.

PITTSBURGH DISTRICT

Doherty, Joseph D., Consulting Engineer, Island Creek Coal Sales Co., Guaranty Bank Bldg., Huntington, W. Va.

Ritchey, M. H., District Manager, Robert W. Hunt Co., 923 Penn Ave., Pittsburgh 22, Pa.

* J denotes Junior Member.

(*Continued on page 90*)

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(*Continued from page 88*)

Svaline, John, Chemist, Pennsylvania Industrial Chemical Corp., Clairton, Pa. For mail: 120 State St., Clairton, Pa.

ST. LOUIS DISTRICT

Bergendoff, R. N., Partner, Howard, Needles, Tammen & Bergendoff, 1805 Grand Ave., Kansas City 8, Mo.

Engibous, J. C., Soil Biochemist, Monsanto Chemical Co., 800 N. Twelfth Blvd., St. Louis 1, Mo.

Kansas, State of, Purchasing Div., Eugene W. Hiatt, Director of Purchases, Department of Administration, Statehouse, Topeka, Kans.

SOUTHERN CALIFORNIA DISTRICT

Allison, J. R., Director of Research and Control, Leffingwell Chemical Co., Box 191, Whittier, Calif.

Gasper, L. W., District Manager, Robert W. Hunt Co., 6353 Miles Ave., Huntington Park, Calif.

McColgan, John M., Technical Director, Western-Pacific Container Div., Stauffer Chemical Co., 3211-15 E. Twenty-sixth St., Los Angeles 23, Calif.

Price, Ralph J., Chief Metallurgist, Bethlehem Pacific Coast Steel Corp., Box 2057, Terminal Annex, Los Angeles 54, Calif.

SOUTHWEST DISTRICT

Thornhill-Craver Co., Inc., Mechanical Engineer, Box 1184, Houston 1, Tex.

Nagy, Alex G., Statistician and Market Analyst, Lone Star Brewing Co., Box 2060, San Antonio, Tex.

Tycer, William A., Civil Engineer, Box 111, Amite, La.

WASHINGTON (D. C.) DISTRICT

Shepherd, T. G., Vice-President, Cinder Block Co. of Richmond, Inc., Box 5027, Richmond, Va.

WESTERN NEW YORK-ONTARIO DISTRICT

Hanford, Carlton Mead, Supervisor, Engineering Lab., The Carborundum Co. Coated Products Div., The Carborundum Co., Niagara Falls, N. Y.

Kohlhagen, Fred A., Development Manager, Globe Woven Belting Co., Inc., 1400 Clinton St., Buffalo 6, N. Y.

McIntyre, William A., Metallurgist, Thompson Products, Ltd., St. Catharines, Ont., Canada.

UNITED STATES AND POSSESSIONS

Aseff, George V., Sr., Engineer, Test Lab., 72-04, Lockheed Aircraft Corp., Marietta, Ga. For mail: 1015 Avondale Ave., S. E., Atlanta, Ga.

Board of Public Instruction of Dade County, Fla., Arthur F. Hackney II, Coordinator, Testing Div., 275 N. W. Second St., Miami 36, Fla. For mail: 2925 N. W. Forty-first St., Miami, Fla.

OTHER THAN U. S. POSSESSIONS

Cia. Mogiana de Estradas de Ferro, J. M. Pereira Brasil, Chefe do Controle, Caixa Postal no 27, Campinas, Estado de São Paulo, Brazil.

Columbia Cellulose Co., Ltd., M. Wayman, Technical Director, Box 1000, Prince Rupert, British Columbia, Canada.

Hyams, Harry, In Charge of Standardization, Shell Petroleum Co., Ltd., 16 Finsbury Circus, London, E.C.2, England.

Kimmons, Robert L., Research and Control Section, General Engineering Technical Group, Creole Petroleum Corp., Apartado 172, Maracaibo, Venezuela.

Tissot, Roger, President, Sociedad Construcciones Tissot Y Cialtda, Calle 87, No. 8-64, Bogota, Colombia.

DEATHS...

A. R. Blood, Allis-Chalmers Manufacturing Co., Tractor Div., Milwaukee, Wis. (October 1, 1953). Representative of his company since 1947 on Technical Committee L on Tractor Fuels of Committee D-2 on Petroleum Products and Lubricants.

Colin G. Fink, Professor Emeritus of Chemical Engineering at Columbia University, and Head of its Division of Electrochemistry from 1922 to 1950, died September 16, 1953, in Red Bank, N. J. Member of ASTM Committee B-1 on Wires for Electrical Conductors since 1944. A Past-President of the Electrochemical Society, and a member of the staff of *Chemical Abstracts,* Dr. Fink had studied at Columbia and at Leipzig. He joined General Electric Co. on his return to this country about 1907, and while a research engineer there he originated the drawn tungsten filament for lamps and the platinum lead-in-wire for lamps and radio tubes. He later became head of the Chile Exploration Co., where he invented the insoluble anode for copper. Between 1921 and 1947 he was secretary and editor of the *Journal of the Electrochemical Society.*

Werner Finster, Chief Metallurgist, Textile Machine Works, Foundry Div., Reading, Pa. (August 15, 1953). Partici-

(*Continued on page 92*)

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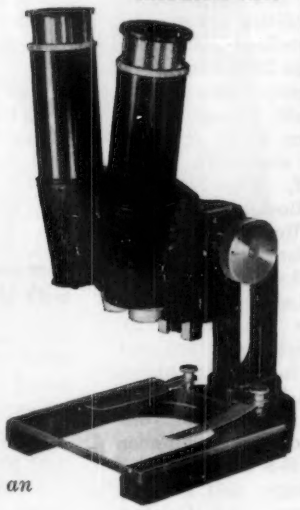

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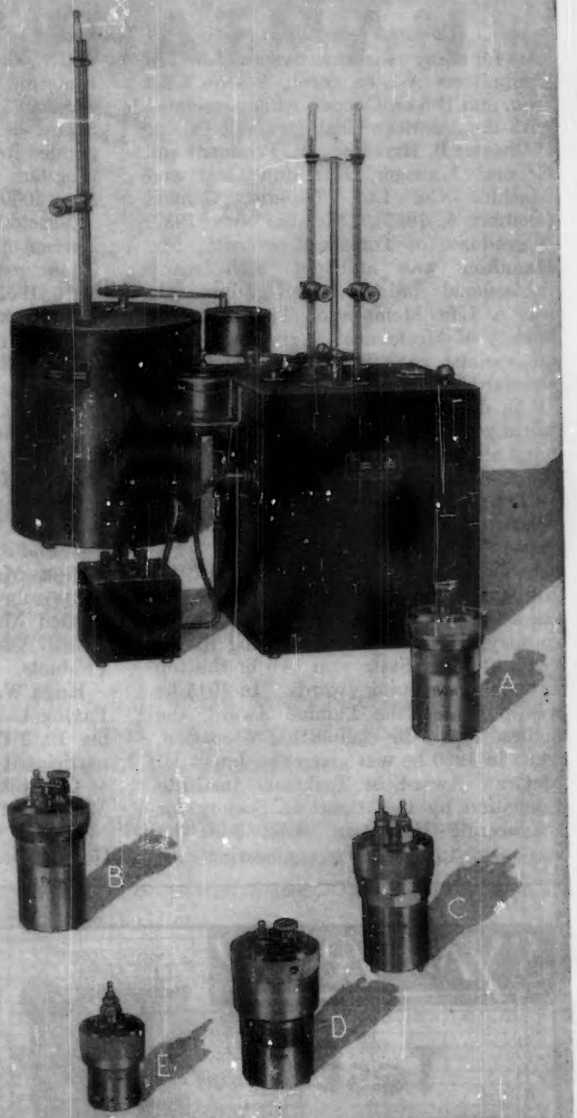

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(*Continued from page 90*)

pant for many years in activities of ASTM Committees A-1 on Steel, A-3 on Cast Iron, and B-5 on Copper, while associated with the American Chain & Cable Co.

Chester B. Hamilton, Jr., President and General Manager, Hamilton Gear and Machine Co. Ltd. Toronto, Canada (October 5, 1953). Member since 1937. A graduate of Toronto University, Mr. Hamilton was affiliated with many professional and technical groups. He was a Life Member of The American Society of Mechanical Engineers, serving on various committees concerned with standards for gears. During World War II he developed a substitute bronze for worm gears to conserve scarce tin and offered all industry the free rights to utilize the analysis.

Harry P. Hammond, Dean Emeritus, School of Engineering, The Pennsylvania State University, State College, Pa. (October 21, 1953). Member since 1944. Recognized as one of the leading figures in the field of engineering education in the country, Dean Hammond during his 14 years at Penn State won two of the top national engineering awards. In 1945 he was presented the Lamme Award, the highest honor in engineering education, while in 1950 he was given the James H. McGraw Award in Technical Institute Education by the American Society for Engineering Education. Last June he was one of two leaders in engineering education to be named honorary members of ASEE, the first time the honor had been conferred in the 81-year-old history of the Society. During his term as Dean, the School of Engineering at Penn State expanded its physical facilities and research program, and its enrollment increased from 1000 to more than 2500 students.

Harold E. Hilts, Deputy Commissioner, Bureau of Public Roads, Department of Commerce, Washington, D. C. (September 5, 1953). Member since 1914.

Ray A. Moncrieff, Vice-President, Charles T. Main, Inc., Boston, Mass. (September 28, 1953). Representative of company membership for the past year.

Herbert W. Mundt, Scientist in Charge, Canal Zone Corrosion Laboratory (NRL), Rodman, Canal Zone (September 19 1953). Member of Society since 1940, and active since 1947 in the following technical groups: Committees A-5 on Corrosion of Iron and Steel; B-3 on Corrosion of Non-Ferrous Metals and Alloys, and a number of its subcommittees; B-8 on Electrodeposited Metallic Coatings; and D-1 on Paint, Varnish, Lacquer, and Related Products.

Hugh W. Skidmore, President, Chicago Paving Laboratory, Chicago, Ill. (October 19, 1953). Member since 1922, and participant for many years in the activities of Committee D-4 on Road and Paving Materials.

Horace G. Swan, Engineer of Tests, Gould Coupler Works, The Symington-Gould Corp., Depew, N. Y. (September 7, 1953). Representative of his company in the Society, and on Committee A-1 on Steel, and its Subcommittee IV on Spring Steel and Steel Springs, since 1947. Mr. Swan also had served for six years on the Western New York-Ontario District Council.

Leo L. Vasold, Metallurgical Engineer, The Electric Auto-Lite Co., Toledo, Ohio (May 26, 1953). Representative of company membership since 1945.

Armour Research Contract with Uruguay

ARMOUR Research Foundation of Illinois Institute of Technology, Chicago, will extend its technological experience and services to the South American republic of Uruguay under a contract just signed with that nation.

A study will be made of means to improve existing industries and the possibility of establishing new ones through the applications of research and engineering technology. An investigation will also be made with a view toward creating in Uruguay an independent industrial research institute to serve the technical-economic needs of the country.

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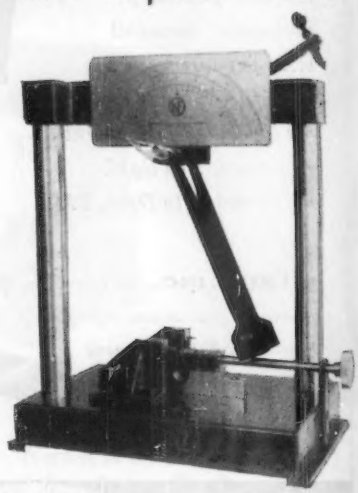

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NEWS NOTES ON

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CATALOGS AND LITERATURE

Viscometer—An illustrated four-page circular, now available from Brooksfield Engineering Labs, Inc., discusses viscosity problems, lists advantages of the Brookfield Viscometer in the saving of time and trouble, and itemizes a three-step method for making accurate viscosity determinations in seconds.

Brookfield Engineering Labs., Inc., 242 Cushing St., Stoughton, Mass.

Developments in Laboratory Apparatus—Issue Number 78 of the "Cenco News Chats" features an interesting article on the use of a portable gas testing absorber for measuring the natural gasoline content of natural gas. Another article discusses viscosity and describes equipment for its determination. Detailed information about several other laboratory instruments is also included. A free copy may be obtained on request.

Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.

Instrument Topics—Recently announced by Consolidated Engineering Corp. is Vol. 7, No. 3, of "CEC Recordings." Bulletin CEC-1200-27 lists seven articles on modern instruments and instrumentation.

Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

General Laboratory Apparatus—A recent issue of the "Eberbach Announcer" contains several articles dealing with laboratory apparatus. The featured story concerns the Bausch & Lomb Centennial. Equipment listed in the magazine includes wedge interference filters, wide field microscopes, Vanton circulating pumps, multiple hammer pulverizing mills, pressure reactors, torsion balances, laboratory sterilizers, and other supplies.

Eberbach & Son Co., 200 E. Liberty St., Ann Arbor, Mich.

Reflectometer—A four-page leaflet describing this new instrument has been released by Gardner Laboratory, Inc. It is stated that this reflectometer, developed at the Gardner Laboratory, automatically measures reflectance, color, and with attachments, gloss. Bulletin No. 132 gives descriptive data and under specifications lists quantity measured and indicates some applications according to ASTM Methods.

Gardner Laboratory, Inc., Bethesda 14, Md.

Precision Electronic Timer—A brochure describing and illustrating a new electronic timer for viscosity measurements has been announced by Hallikainen Instruments. Described as of Shell Development Design, this instrument has been developed principally for viscosity measurements, and for similar timing requirements. It is said that the outstanding feature of this timer is that it provides an accurately regulated 60 cycle voltage, which eliminates possible timing errors due to fluctuating frequency. Counters accurate to a tenth of a second.

Hallikainen Instruments, 1341 Seventh St., Berkeley, Calif.

New Laboratory Equipment Catalog—Just off the press is a twelve-page booklet entitled "Supplying the Nation's Laboratories." This pamphlet describes and illustrates laboratory supplies for control, research, or development work. Illustrations feature testing equipment for metallurgical, medical, and petroleum fields.

Harshaw Scientific Div. of The Harshaw

(Continued on page 96)

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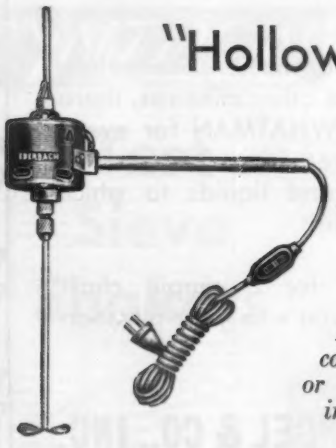

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- ★ **High-pressure chamber chromium plated for maximum corrosion resistance**
- ★ **Equipped with pressure safety valve**
- ★ **Meets requirements of ASTM Standard Method C151-49**
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Write for Bulletin No. 1212

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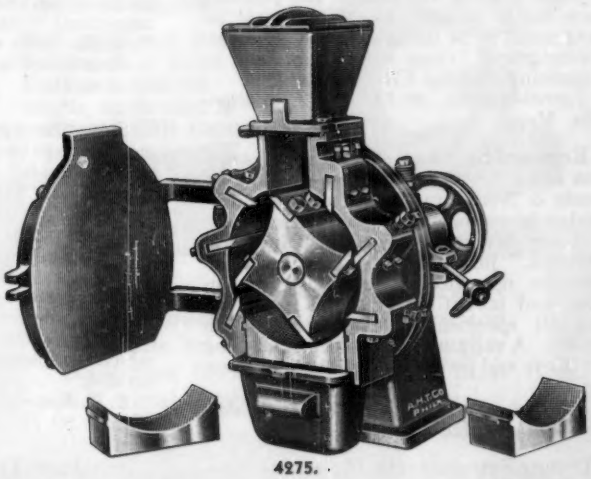
A.H.T. CO. SPECIFICATION

WILEY LABORATORY MILL

For the preparation, with minimal loss of moisture, of a wide variety of materials for laboratory analysis



4275.

WILEY LABORATORY MILL, Standard Model No. 2. For the preparation, with minimal loss of moisture, of a wide variety of materials such, for example, as:

animal hair, bones, fertilizer materials, grain, leather, plastics, seed, tanning materials, etc.

Now furnished with either a drawer removable from the front or a chute for collecting the sample directly into 16 oz. glass jar with standard screw neck, or into a bag, table drawer, etc. The use of a glass jar enables the operator to observe the progress of the milling without interrupting operation.

Four hardened steel knives on a revolving shaft work with a shearing action against six knives bolted into the frame. This shearing action tends to avoid changes in sample such as temperature rise, loss of moisture, liquefaction, contamination, etc., making the Mill satisfactory for many materials which cannot be reduced by other mechanical means.

A sieve is dovetailed into the frame so that none of the material comes from the grinding chamber until it can pass through the mesh. Mill is 22½ inches high and occupies floor space 14½ x 18 inches. Requires a motor of ½ h.p. or more for operation.

4274-W. Wiley Laboratory Mill, Standard Model No. 2, as above described, with chute, three 16 oz. jars with plastic caps, and three sieves of 0.5 mm, 1 mm and 2 mm mesh, respectively. With pulley for V-belt and set of wrenches, but without motor.....433.00

4275. Ditto, but with cast aluminum drawer, removable from the front, in place of chute and glass jar; without motor.....420.50

NOTE—Both models also furnished complete with motor for 115 volts, 60 cycles, single phase a.c., on pedestal base 16 inches high, at $751.50 and $739.00, for chute and drawer models respectively.

More detailed description of above and other models of the Wiley Laboratory Mill sent upon request.

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Laboratory Apparatus and Reagents

WEST WASHINGTON SQUARE PHILADELPHIA 5, PA.

Teletype Services: Western Union WUX and Bell System PH-72

(*Continued from page 94*)

Chemical Co., 1945 E. 97th St., Cleveland 6, Ohio.

Plane Grating Spectrograph—A brochure, "JAco Ebert 3.4 Meter Plane Grating Spectrograph," has just come from the press and is now available from Jarrell-Ash Co. This literature describes the instrument as the first commercially available spectrograph to be equipped with a plane grating and claims the performance made possible by this optical arrangement to be unmatched by any other spectrograph. Copy may be obtained by requesting Catalog EB-10-53.

Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.

Keys and Switches—Complete information about keys and switches supplied by Leeds & Northrup Co. for use in industrial or laboratory applications is available in a new twelve-page catalog, "Keys and Switches," just published. To facilitate selection of switches, necessary dimensions and mounting directions are given and all specifications are arranged in tables. A copy of Section EU of Catalog E, "Keys and Switches," will be sent upon request.

Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Testing Ferromagnetic Materials—Bulletin No. 10, an eight-page pamphlet illustrating and describing Multi-Method Equipment for Non-Destructive Testing of Ferromagnetic Bars, Wire Rods, and Tubing has just been published.

Magnetic Analysis Corp., 42-44 Twelfth St., Long Island City N. Y.

Oxygen Bomb Calorimeter—A new six-page bulletin now available from the Parr Instrument Co. describes this adiabatic oxygen bomb calorimeter for determining the heat of combustion of any solid or liquid fuel. Calorific tests can be made rapidly and accurately in this instrument without complex radiation calculations. The new bulletin describes the principal parts of the calorimeter and mentions its important features. Copies of Specification No. 1200 will be mailed on request.

Parr Instrument Co., 211 Fifty-third St., Moline, Ill.

Scientific Apparatus and Methods—A new 32-page issue of "Scientific Apparatus and Methods" No. 16, released by E. H. Sargent and Co., features a paper on the technique of amperometric titration utilizing the Sargent Ampot, synchronous rotator, micro-buret, half cells, and microelectrodes. Also described and illustrated are: centrifuges, electrophoretic papers, spectrophotometers, magnifiers, and other chemical laboratory equipment, which supplement the Sargent No. 100 catalog.

E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Ill.

Petroleum Testing Apparatus—A catalog issued by Technical Equipment Co. lists description, delivery, and price of petroleum testing apparatus. It is stated that this equipment conforms to ASTM specifications. ASTM methods of test are listed for all items. All apparatus is sold direct to the customer.

Technical Equipment Co., 743 Dwight Way, Berkeley 10, Calif.

INSTRUMENT NOTES

Testing Machine—A new Model FGT SR-4 type universal testing machine having several new features is announced by Baldwin-Lima-Hamilton Corp. The Model FGT, a machine of 50,000 lb capacity in tension and compression, is the first production testing machine in which SR-4 resistance wire strain gages are used for load measurement. One improvement provides greater convenience and flexibility of automatic load reversal. A new overload clutch is among the safety devices protecting the machine and protects the drive motor against exceeding torque rating. Electrical devices protect the weighing system, and limit switches prevent overtravel.

Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

New Micro-Microammeters—In microcurrent instrumentation for industrial control, two new instruments, the Vibrating Reed and Logarithmic Scale Micro-Microammeters, have been announced by Beckman Instruments. These instruments can be employed to measure, record, and control microcurrents on the order of one millionth of a millionth of an ampere. They measure the effect of radioactivity on ion chambers or similar sensing devices.

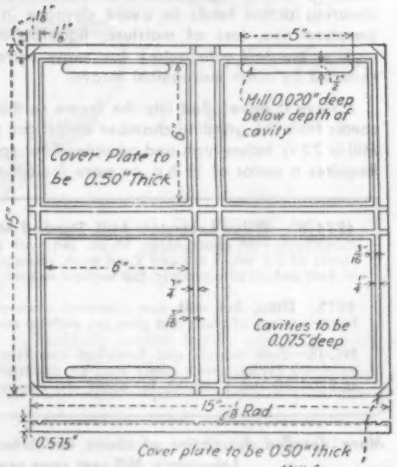
(*Continued on page 98*)

MOLDS AND DIES

HOGGSON BRAND Since 1849

FOR RUBBER TESTING

Single and multi-cavity molds made to order for making samples for testing adhesion, abrasion, flexing, compression, rebound. Years of experience in rubber. Prompt service.


5"
Mill 0.020" deep below depth of cavity
Cover Plate to be 0.50" Thick
6"
Cavities to be 0.075" deep
15" 1/8 Rad.
0.515"
Cover plate to be 0.50" thick
Mill four corners 1/8 deep for prying mold apart

BENCH MARKER

1" and 2" Centers

Standard ASTM and Federal dies for cutting test tensile and tear strength samples and dies for Slab curing carried in stock. Write for catalog.

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5. For the analysis of source materials and processed products for a variety of hormones and vitamins.
6. For the identification and estimation of numerous substances of nutritional and biological regulatory function, supporting or replacing biological assay.
7. For the determination of halides and sulfate groups by titration with a polarized electrode.
8. For the analytical measurement of innumerable organic compounds containing reducible groups.
9. For specific industrial controls such as the estimation of aldehydes in alcoholic products, the quantitative differentiation of sugars and the control of aging quality in sugars.
10. For the measurement of dissolved oxygen, oxygen demand and metal ions in water and sewage.
11. For many uncommon analyses for which classical procedures are unavailable, less accurate and slower.
12. For the investigation and control of commercial reduction processes.
13. For thermodynamic investigations relating to states of ionic aggregations, mobilities and diffusion rates, solubilities, reaction rates and equilibrium constants.

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TMI NEW MODEL 553 MICROMETER

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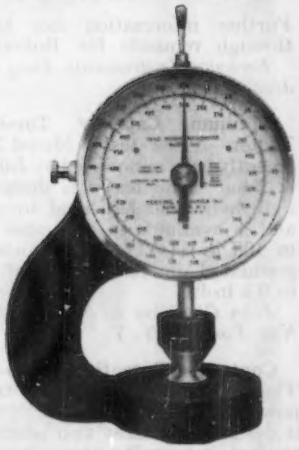
- Capacity .500" in .001" divisions. Easy to read .0005".
- Large 6" dial, Simple zero adjustment.
- Dead weight lead 8 lbs./ inch, Stainless Steel Anvils. Available in different weights, anvils sizes to meet many ASTM standards.



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The second edition of this Manual on Measurement and Sampling of Petroleum and Petroleum Products presents the latest and most practical measurement practices in use today.

The book provides recognized methods for measuring and computing oil in storage and transportation tanks of various types, and for obtaining typical samples. The methods have been revised in this second edition to improve their usefulness and practicability.

Methods included in the manual are as follows:

Gaging Petroleum and Petroleum Products D1085-52T
Measuring the Temperature of Petroleum and Petroleum Products D 1086-52T
Volume Calculations and Corrections in the Measurement of Petroleum and Petroleum Products D 1087-52T
Water and Sediment by Means of Centrifuge D 96-52T
Gravity of Petroleum and Its Products by Hydrometer D 287-52
Sampling Petroleum and Petroleum Products D 270-52T
Sampling Natural Gas D 1145-50T

147 pages, heavy paper cover (February, 1953. . . . Second Edition)
$2.00; to ASTM members, $1.50

American Society for Testing Materials

1916 Race Street, Philadelphia 3, Pa.

(*Continued from page 96*)

Further information can be obtained through requests for Bulletin 332-220.
Beckman Instruments, Inc., South Pasadena, Calif.

Medium Capacity Torsion Spring Tester—A new tester Model No. 942 has recently been announced by John Chatillon & Sons. The tester is designed to test right-hand and left-hand torsion springs, and is available in capacities from 5 up to 100 in-lb. The dyanometer dials are graduated in increments of from 0.02 to 0.5 in-lb.
John Chatillon & Sons, 85-93 Cliff St., New York 38, N. Y.

Controlled-Potential Electro-Analyzer—The controlled-potential Electro-Analyzer now available from Fisher Scientific Co. is designed to meet two needs. For the analyst it permits successive determinations of several metals in one sample—automatically and for the researcher it allows exploration of the whole new field of the electrochemistry of organic compounds.
Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

New Vertical Flow Cabinet Oven—A combination of features in this Standard Model Vertical Flow Oven, recently announced by Grieve-Hendry Co., is said to reduce heat loss with corresponding greater efficiency and lower operating cost. It is stated that these features include metal to metal contact; double gasketed doors with heat trap; 20 per cent more insulation; and high-low selective heat intensity control. These ovens are equipped with an accurate indicating temperature control; a manual interlock for either rapid cooling or purge period operation of blower without heat; an adjustable positive exhaust and intake; and belt driven fans for greater motor life.
Grieve-Hendry Co., Inc., 1811-19 W. Lake St., Chicago 12, Ill.

Conductivity Bridge—A new general-purpose conductivity bridge for electrolytic conductivity and electrical test measurements is announced by Industrial Instruments, Inc. The new instrument has been cataloged as Type RC-16B. It features variable sensitivity control up to a maximum of ⅓ per cent while the range of the instrument is from 0.2 to 2,500,000 ohms with an accuracy of within 1 per cent of measured resistance.
Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.

Fluorimeter—Now in production by Jarrell-Ash Co. is a new G-M Fluorimeter based on an advanced design which eliminates the need for air or water cooling systems and optical meters. The instrument consists of three basic units: an ultraviolet light chamber and simple slide, a detecting and measuring unit, and a power supply.
Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

New Plot-Trace Recording Device—The X-Y Plotter and Recorder, a two coordinate portable recording instrument for continuous curve or discrete point plotting, equally useful for the display of digital information, the plotting of transistor characteristics, or for calibration of such equipment as flow meters, has been announced by Librascope, Inc. A catalog sheet with complete details and specifications is available from the Engineering Sales Dept.
Librascope, Inc., 1607 Flower St., Glendale, Calif.

Homogenizer—A new 27,000-rpm homogenizer specifically designed for laboratory use has been introduced by E. Machlett & Son. Adaptable for both micro and macro work—volumes ranging fom 0.2 to 50 ml—this new unit offers many features. The company describes the apparatus as a top drive type equipped with a universal heavy duty motor linked with a built-in variable transformer. A rate adjustment knob permits fingertip speed control anywhere from 100 to 27,000 rpm. Fluted homogenizing flasks along with steel cutting blades reduce homogenizing time to as little as 15 sec. Complete information is available on request.
E. Machlett & Son, 220 E. 23rd St., New York 10, N. Y.

Small Electron Microscope—A new Electron Microscope is now available from the North American Philips Co. Designated as unit EM-75, it is suitable for analytical work in industrial processing, research, medicine, pathology, and biology, and it utilizes an electron-optical system that includes condenser, objective, and projector lenses. Magnification is continuously adjustable between 1500 and 15,000 diameters and is variable between 10 and 75 kv. Resolving power is better than 100 Å under average operating conditions. The new unit has a magnetic stabilizer for high voltage and lens currents. The electron gun is self-biased, is equipped with an emission meter, and the V-shaped filaments easily replaced.
North American Philips Co., Research & Controls Instruments Div., Inc., Mount Vernon, N. Y.

Scaler—A new Model 183 scaler for use with Geiger or scintillation counters has been announced by the Nuclear Instrument and Chemical Corp. The instrument features controls to allow operation for a predetermined number of counts or a predetermined length of time. In addition, Model 183 may be used in conjunction with Model C-110 sample changer for completely automatic counting of up to 50 radioactive samples.
Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago 10, Ill.

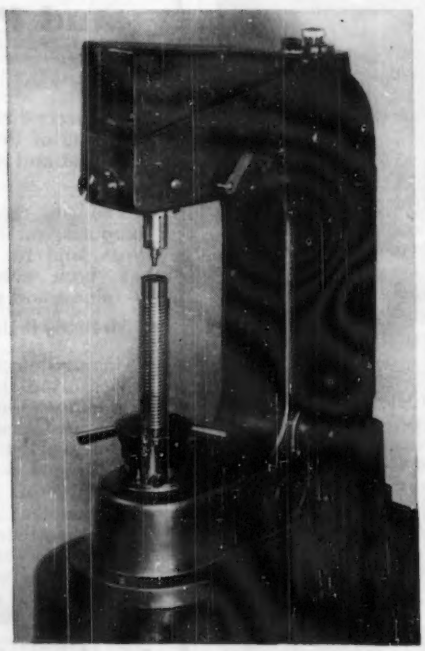
Testing Cabinet—A new type of testing cabinet was recently announced by The Package Materials Laboratories, Inc. Cabinet 15-CF was designed and built for any type of moisture-vapor testing within the limits of minus 20 F to plus 200 F with a relative humidity range of 18 per cent to slightly under 100 per cent. This type of cabinet is used for testing any materials which may be affected by temperature and humidity or humidity alone. Further information available from Dept. FM-30.
Package Materials Laboratories, Inc., 461 Crescent Rd., Hatboro, Pa.

Personnel Safety Radiation Alarm—Radiation Counter Laboratories, Inc., has announced the availability of the R-VOX,

(*Continued on page 100*)

SPEEDS AND SIMPLIFIES HARDNESS TESTS

New, Low-Cost Standard and Superficial Testers Offer Magnified Optical Readings; Automatic Load Changing



Imported and serviced by
OPPLEM COMPANY, INC.
Established 1890
83 Uhland St., E. Rutherford, N. J.

Here they are—the first hardness testers to provide magnified optical readings. Only the new *Galileo* Hardness Testers project their measurements on a screen, with ball and diamond Rockwell scales easily visible at high magnifications; Brinell numbers easily obtained through readings on the screen. And only *Galileo* enables you to change loads quickly and automatically by simply turning a dial. All loads are obtained by exact, precision-made weights, insuring absolute constancy in calibration.

Exceptionally rugged and sensitive, the instruments are enclosed in dust-proof, grease-proof metal cases for trouble-free operation. Designed for Rockwell measurements on any type of metal within the range of 30 to 1000 Brinell units. They can also be used for Brinell tests, special loads and for Vickers measurements. Built-in oil damper with external control enables operator to regulate speed with which load is applied. The Standard Tester provides loads of 31,2 — 60 — 62,5 — 100 — 150 — 187,5 — kgm; the Superficial Tester provides loads *starting at 5 kgm.* Diamond cone and steel ball penetrators. Maximum throat opening 7½". Wide range of accessories. Reasonably priced.

For details on the Hardness Testers and other *Galileo* instruments of modern functional design, write to the address below—Dept. AB.

GALILEO
OPTICAL INSTRUMENTS

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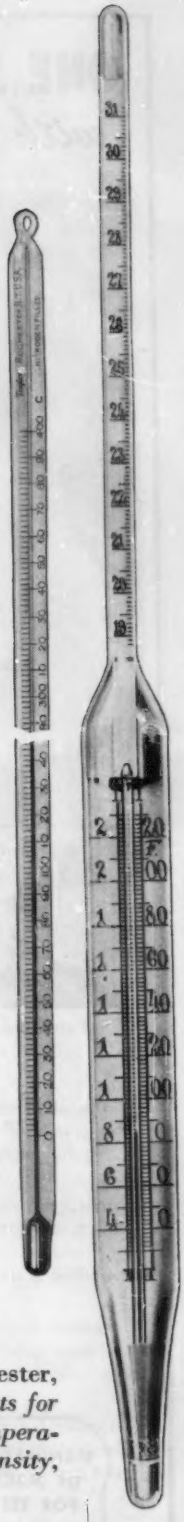
THE NAME TAYLOR IS YOUR PROTECTION

on etched stem thermometers & hydrometers



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SPECIAL DESIGNS made to order for scientific, research and production purposes. Available with all scales recognized by the Bureau of Standards.

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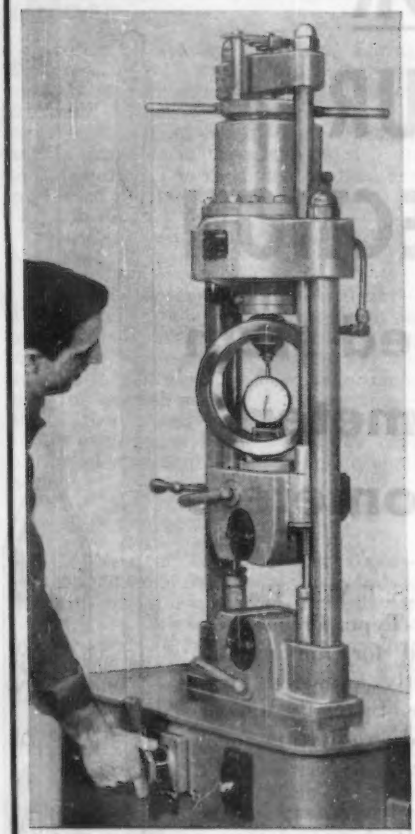
Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.*

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

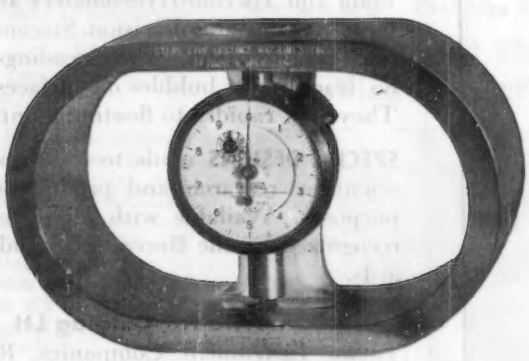
ONE MAN DOES THE WHOLE JOB
with a Steel City Proving Ring!



Steel City direct reading type proving rings allow one man to calibrate a testing machine. When the ring is under load it is only necessary to observe the deflection shown by the dial indicator. No adjustment of the proving instrument is required—both hands are left free to run the machine.

•

Steel City proving instruments are forged from a special alloy steel and carefully heat-treated to uniform hardness. Graduations on the indicator are in .0001". Readings are translated into pounds by calibration report furnished with the ring. Calibration by National Bureau of Standards available. All rings conform to A. S. T. M. Standard E-4.



Models for calibrating Brinell and Universal Testing Machines. Capacities from 500 pounds to 100,000 pounds. Write for descriptive bulletin.

Instrument shown in upper picture has 100,000 pound capacity. Oval ring has 2500 pound capacity.

MANUFACTURERS OF MACHINES FOR TESTING PHYSICAL PROPERTIES OF METALS

Brinell, Ductility, Universal, Tensile, Compression, Transverse, Hydrostatic, Special Testing Machines, Flex-Tester and Proving Instruments

Steel City Testing Machines Inc.

8813 LYNDON AVE. • DETROIT 21, MICH.

(*Continued from page 98*)

a new personnel safety radiation alarm, which gives off an audible alarm informing the user when an overdose of radiation has been received. This instrument was developed in conjunction with Oak Ridge National Laboratories for use in all laboratories where gamma radiation exists. For detailed specifications, write Dept. PF-10.

Radiation Counter Laboratories, Inc., Nucleonic Park, Skokie, Ill.

Synchronous Rotator—A synchronous rotator recently introduced by E. H. Sargent & Co. is designed for use in amperometric titrations with rotating metallic micro electrodes, wherein constant speed of rotation is essential. It incorporates a hollow shaft chuck to hold the electrode securely in line with the axis of rotation and a constant speed drive, assembled together with a terminal connecting post and line switch.

E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Ill.

Precision Dynamometer—A new Precision Dynamometer for measuring spring tension, starting torque, and the force required to actuate delicate mechanisms has been announced by the George Scherr Co. The new instrument is an aid in determining and checking the pressure required to overcome spring tension and other kinds of resistance in fine precision mechanisms. It is available in two models, small and large, each in several ranges, in grams of pressure, acting in both directions. Illustrated pamphlet can be obtained from the company.

George Scherr Co., 200 Lafayette St., New York 12, N. Y.

Brinell Hardness Testing Machine—A production model Brinell Hardness Testing Machine, designed to fit directly into a conveyor system, is announced by Steel City Testing Machines, Inc. Adapted from the Company's standard hydraulically operated direct reading type of tester, the new unit greatly facilitates handling of parts and thereby speeds up the testing process. Highlight of the new design is a roller conveyor arranged in conjunction with the anvil of the tester. The machine, designated Model KDR-10X, is motor driven, hydraulically operated. Complete details available from the company.

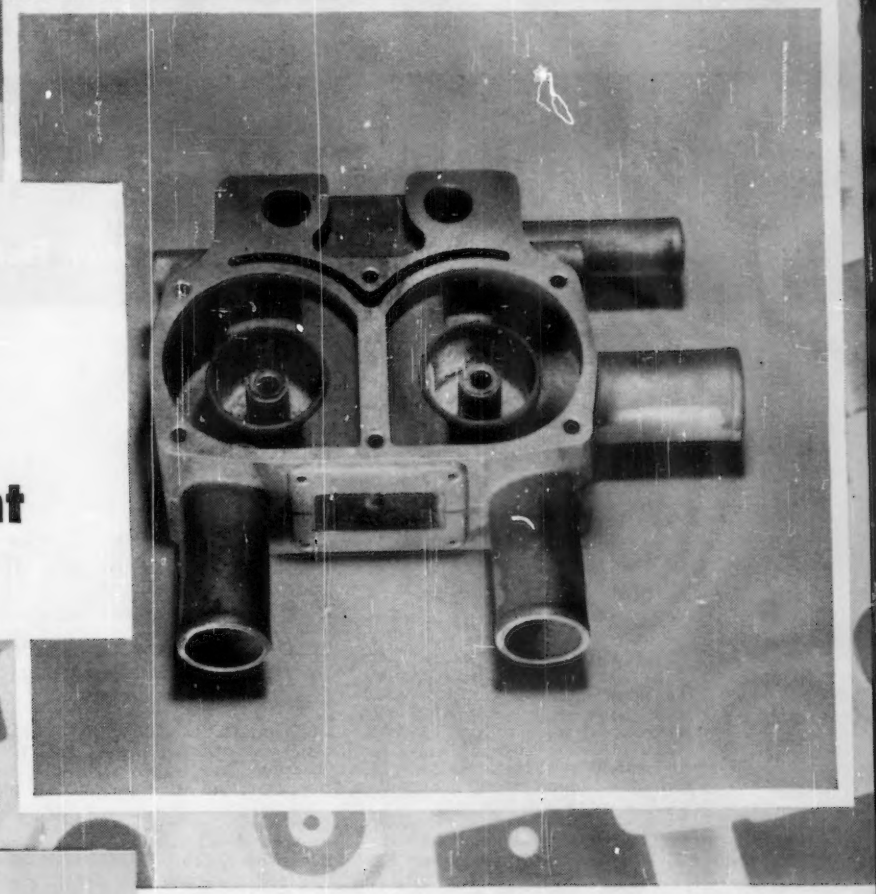
Steel City Testing Machines, Inc., 8817 Lyndon Ave., Detroit 21, Mich.

INSTRUMENT COMPANY NEWS

Beckman Instruments, Inc., South Pasadena, Calif.—Arnold O. Beckman, President, has announced formation of a new operating division to handle development, engineering, and production work under selected government contracts. The division will be located at 220 Pasadena Ave., South Pasadena. J. L. Fahey, vice-president and controller of Beckman Instruments, Inc., will be the general manager for the new Arga Division.

Thomas A. Edison, Inc., West Orange, N. J.—Dr. Donald W. Collier, Director of Research, announces the appointment of Dr. George M. Anderson as head of the Engineering Development group at Edison Laboratory. Dr. Anderson's chief function will be to reduce to working experimental models, the new product and product-improvement research being carried on in the new $500,000 laboratory in

(*Continued on page 102*)



PRODUCT:
De-icer pump casting
MATERIAL:
Aluminum alloy
EQUIPMENT:
140 kv x-ray machine

What's the right X-ray film?

KODAK INDUSTRIAL X-RAY FILM, TYPE A

IN ADDITION to the vital importance of this unit to the safety of aircraft and airmen, close machining was called for. So to be sure that no porosity existed to cause weakness or waste valuable machining time, all castings were radiographed.

For these radiographs, the radiographer used 90 kv, 60-sec. exposure at 40-in. tube distance—no lead screens—and Kodak Industrial X-ray Film, Type A.

This film is the first choice for examination of light alloys using short exposures at low voltages. It also has high contrast with fine graininess and speed enough to take full advantage of high kilovoltage equipment in radiographing thick or dense materials.

A RIGHT FILM FOR EVERY PROBLEM

Whatever your radiographic problem, you'll find the best means of solving it in one of Kodak's four types of industrial x-ray film. This choice provides the means to check castings and welds efficiently, offers optimum results with varying alloys, thicknesses and radiographic sources.

Type A—has high contrast and fine graininess with adequate speed for study of light alloys at low voltage and for examining heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multi-million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage, without use of calcium tungstate screens.

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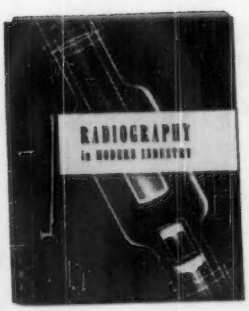

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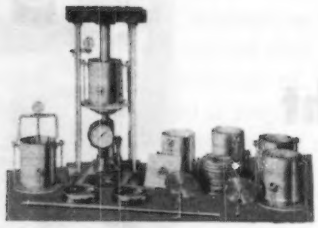
Soil Testing INSTRUMENTS

For A.S.T.M. & Other Official Tests

LIQUID LIMIT DEVICE

For studying the plastic properties of soils as a function of the water content according to ASTM D 423. Gives consistent results in the measurement of the lower limit of viscous flow (liquid limit), plasticity index, flow curve, and flow index.

Consists of an easily detachable, precisely formed brass cup (2 mm. thick), crank and cam mechanism for producing the 1 cm. drop of the cup, and carriage mounted on a hard-rubber base.

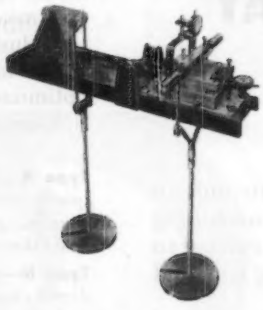


SOIL COMPACTION BEARING RATIO AND EXPANSION APPARATUS

Developed by the California Div. of Highways for determining the relative bearing ratio and expansion characteristics of untreated base, subbase, and subgrade soils, including coarse sand and rock particles up to 3/4-in. in size. Used extensively in conjunction with improved methods of selecting the materials and treating subgrades to maintain the stability of roadways.

SOIL DISPERSION STIRRER

For safe, speedy, and convenient preparation of soil dispersions according to ASTM D 422. Cup can be withdrawn without tilting or spilling contents; propeller can not strike the base, bottom of the cup, or baffles; cup automatically positioned and held firmly in place; self-locking device holds stirring mechanisms at any desired height.



SOIL SHEAR TEST MACHINE

For determining, conveniently and accurately, the behavior of soils under shearing stress in all types of construction dealing with the use of soil or sand.

Available for specimens 3 1/2-in. square or 2.53-in. in diameter. One dial gage registers shearing strain; another dial registers compressional deformation.

OTHER SOIL TESTING INSTRUMENTS AVAILABLE FROM AMINCO

Sampling Augers, Tubes, and Hammers . . . Sample Splitters . . . Mortars and Pestles . . . Sieves and Sieving Machines . . . Bouyoucos Hydrometers and Baths . . . Shaw Pipette Racks . . . Sticky Point Testers . . . Proctor Plasticity Needles . . . Compaction Control Kits . . . Permeameters for Compacted Specimens . . . Compression and Loading Devices . . . Percolation and Settlement Testing Apparatus . . . Pressure Cells . . . Cone Penetrometers . . . DESCRIBED IN CATALOG R-52

AMINCO Laboratory Instruments

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(*Continued from page 100*)

physical, chemical, and analytical fields. Previously Dr. Anderson was connected with the Westinghouse Atomic Power Div. in Pittsburgh, Pa.

Farrand Optical Co., Inc., New York, N. Y.—A West Coast engineering office has been opened at 5896 W. Adams Blvd., Culver City, Calif., according to a recent company announcement. R. A. Hamilton has been appointed Consulting Engineer, Optical Tooling, and E. L. Fischer named Technical Representative.

Measurements Corp., Boonton, N. J.—H. W. Houck, President, recently announced the election of Martial A. Honnell as a Vice-President and Chief Engineer of Measurements Corp. The company, a wholly owned subsidiary of Thomas A. Edison, Inc., manufactures Standard Signal Generators and precision electronics instruments. Mr. Honnell formerly was professor of electrical engineering in charge of communications and electronics at the Georgia Institute of Technology.

Precision Scientific Co., Chicago, Ill.—According to a company announcement, James A. Loftus has been named Production Manager. Mr. Loftus has been associated with the Precision Scientific Co. since 1935.

LABORATORY NEWS

Arrow Laboratories, Inc., New Haven, Conn.—Announcement is made that Arrow Labs., formerly located at 151 Truman St., have moved to a new and larger factory located at 419 Chapel St., New Haven, where they will occupy the entire building.

Bjorksten Research Labs., Inc., Chicago Ill.—Recent additions to the staff of Bjorksten Research Labs., include Robert E. Wedemeyer, formerly research assistant at West Kentucky State College; Robert G. Splies, recently senior chemist at Solvay Process Div.; Robert R. Walters formerly with Mathieson Chemical Corp.; William S. Fiedler, previously connected with Industrial Nucleonics Corp.; Elizabeth Bergenn, prior service with *Good Housekeeping Magazine;* and Betty Ann Harker, formerly technical editor for U. S. Forest Products Laboratory.

International Testing Laboratories, Newark, N. J.—Norman Gardner has been appointed as Chief Spectroscopist in the Spectrographic Div. Mr. Gardner was formerly Chief Spectroscopist with the State of New Jersey, Dept. of Health.

Smith-Emery Co., Los Angeles, Calif.—The new address of the company is 781 E. Washington Blvd., Los Angeles 21. The new quarters provide greater laboratory and office space and increased facilities for future growth. This is the second move the company has made in forty-three years of service to industry.